CID Bio-Science Inc.

Portable Instruments for Precision Plant Measurement

Portable Ethylene Gas Analyzer CI-900 Instruction Manual

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INTRODUCTION

Congratulations on the purchase of your new CI-900 Portable Ethylene Gas Analyzer. The CI-900 provides accurate real-time measurement of ethylene gas concentrations in a compact instrument suitable for field and laboratory use. At the core of the instrument is an electrochemical sensor that offers extraordinary sensitivity to ethylene, at levels as low as 0.01 ppm (10 ppb) in air.

Ethylene production is known to increase in response to plant stress and during ripening and maturity, and until recently, sensitive ethylene measurements were available only through elaborate and expensive gas sampling and gas chromatography analysis. The intent of the CI-900's portable design is to aid the research community in developing real-world ethylene management applications for the benefit of growers, processors, and consumers.

The CI-900 analyzes the concentration of ethylene in a gas sample for the purpose of research or ethylene management. The CI-900 employs an electro-chemical sensor as well as several other sensors for temperature, humidity, GPS location, and optionally CO_2 (high and low range), O_2, and extended ranges of ethylene. During a sample, the subject gas travels across the surface of the electrode and diffuses into the electrochemical cell where ethylene is oxidized. The current created by the oxidation is measured and interpreted as the concentration of ethylene (reported in parts per million or ppm).

We hope you enjoy using your CI-900 Portable Ethylene Gas Analyzer.

Figure 1: The CI-900 Portable Ethylene Analyzer front panel and display.

Features

- High sensitivity to C_2H_4 (0.01 ppm – 20 ppm)
- CO_2 sensing capability (optional)
- Compact portable form factor (2.43Kg)
- Real time continuous monitoring
- Internal data logging and storage (4GB SD card included)
- Automatic or manual data logging
- User adjustable sampling rate
- Transflective display enables easy viewing in direct sunlight
- Rechargeable Li-Ion battery provides 4 hours of monitoring in the field
- Multiple configurations to accommodate *in vivo* research and controlled atmosphere monitoring
- Instantaneous and accumulated measurement modes
- Quick connect sampling ports
- Data saves in .csv (commas separated value) file
- Configured for domestic and international operation: 110 VAC, 60 Hz or 230 VAC, 50 Hz
- Non-destructive measurements
- Mini-USB chargeable and Mini-USB data download
- GPS and time-date stamped data records
- External wire terminals for fixed location monitoring or control applications

Figure 2: The removable SDcard on the CI-900 makes data transfer quick and simple.

Specifications

CI-900 Specifications	
High Resolution Ethylene Sensor	Electrochemical
Air Sampling Rate	0.2 Liters/minute
Sample Rate	Open Loop - Monitoring @ 5 sec intervals
Nominal Range	0-15 ppm, upper limit is 20 ppm
Resolution	1 ppbv
Accuracy	5 % at 10 ppm; 10% at 1 ppm; 10% at 100 ppb; adjusted for temperature and humidity
Display	Sunlight visible transflective LCD
Operating environment	0°C - 45°C (0-90% humidity non-condensing)
Battery Capacity	4 hours - Rechargeable Li-Ion (5000 mAh)
Dimensions	183.5mm x 111mm x 120mm
Weight	2.43Kg
Enclosure	Anodized aluminum
Warm-up time	<5 minutes
Optional Sensors	
Low Resolution Ethylene Sensor	Ethylene Oxide
Nominal Range	1 – 100 ppm
Resolution	< 0.1 ppm
Response time	< 5 minutes
Operating environment	0°C - 50°C (15-90% humidity non-condensing)
Weight	6 g

Optional Sensors	
High Resolution Carbon Dioxide Sensor	Low-Power Non-Dispersive Infrared Gas Analyzer
Chopping Frequency	1Hz
Source Life	5000 Hours
Nominal Range	1 - 2000ppm (Standard)
	0 - 3000ppm (Optional)
Resolution	0.1 ppm
Repeatability	±0.1ppm (short term)
Accuracy	< ±2% up to 3000ppm
Sample Cell	100mm x 10.2mm (3.94" x 0.4" diameter)
Warm-up time	<3 minutes
Weight	172.6 g
Low Resolution Carbon Dioxide Sensor	Infrared Sensor, Pyroelectric detector
Nominal Range	0 – 5% (50000 ppm)
Zero resolution	1 ppm
Full scale resolution	100 ppm
Zero repeatability	±10 ppm
Full scale Repeatability	±500 ppm
Accuracy	1.5% of Full Scale
Lifetime	>5 years
Warm-up time	<3 minutes
Weight	7 g
Oxygen Sensor	
Nominal Range	0-100%
Operating environment	0°C - 55°C (5-95% humidity non-condensing)
Weight	7 g

OPERATING INSTRUCTIONS

To turn the instrument on, press the green power button. The top of the display reads CI-900 and the current firmware version the unit is running. For information on the latest firmware version, please visit the CI-900 software webpage (http://www.cid-inc.com/ci-900-software.php). The line underneath this states "CID Bio-Science". Below this, a menu will appear on the display with the following options: Measure, Setup, View and File. You are now at the CI-900 Main Menu. After the instrument is powered on, the uptime and battery life remaining will be displayed on the bottom line. The uptime, or time the instrument has been powered on, is displayed in hours: minutes, followed by the battery life in percent.

If the CI-900 does not power on, eject the SDcard or disconnect the mini-USB cable from the front of the instrument. Then, power the CI-900 on. Re-insert the SDcard or reconnect the charger.

Figure 3: The options on the Main Menu of the CI-900.

From the Main Menu, there are four menu options: Measure, Setup, View and File. Use the UP and DOWN arrows to switch between menu options and the RIGHT arrow to select.

Press the POWER button to power off the CI-900.

(**Note**: to force a power off and reset of the CI-900 at any point, a user may press and hold the POWER button for 10 seconds. This "emergency hard shut-down" feature exists to address hardware or software problems and should not be used except when needed, in general, simply pressing the Power button in the typical manner will power off the CI-900).

Unpacking the CI-900

The CI-900 base unit arrives with the CI-900, a black moveable handle, and several accessory parts to use with the instrument. Included are the charger, USB cable, 30 cm of tubing with 2 male quick connects, several different styles of connector pieces and various lengths of tubing (0.3 m to 2 m) to use with the instrument are also provided. Male and female quick connectors could be added to tubing and used to connect sample bags or custom chambers to the CI-900. The CI-900 includes silica gel, used to scrub water from the gas stream, and an external conditioning chamber.

Figure 4: Accessories and parts that arrive with the CI-900.

The CI-900 includes silica gel, used to scrub water from the gas stream.

The CI-900 Field Kit is designed to include parts to non-destructively sample fruit in the field. For this reason, the CI-900FK arrives in a hard-sided carrying case and has a chamber and wand with flexible tubing to sample fruit or plants. The CI-900FK also includes that parts and accessories that arrive with the CI-900.

Figure 5: The CI-900FK arrives with a fruit chamber.

If the CI-900 has an optional CO_2 sensor, the unit will arrive with a jar of soda lime, used to scrub CO_2 from the gas stream. Soda lime is necessary to create a 0 ppm CO_2 gas to be used during the CO_2 zero calibration.

Charging the Internal Battery

The CI-900 arrives with a wall charger that can be used to recharge the CI-900 battery, as well as for continually powering the unit during long-term monitoring.

To charge the CI-900:

- Connect the mini-USB cable to the front panel of the CI-900
- Plug the charger into the wall
- Check the charger status (on/off) and battery life at the "View: Battery" menu

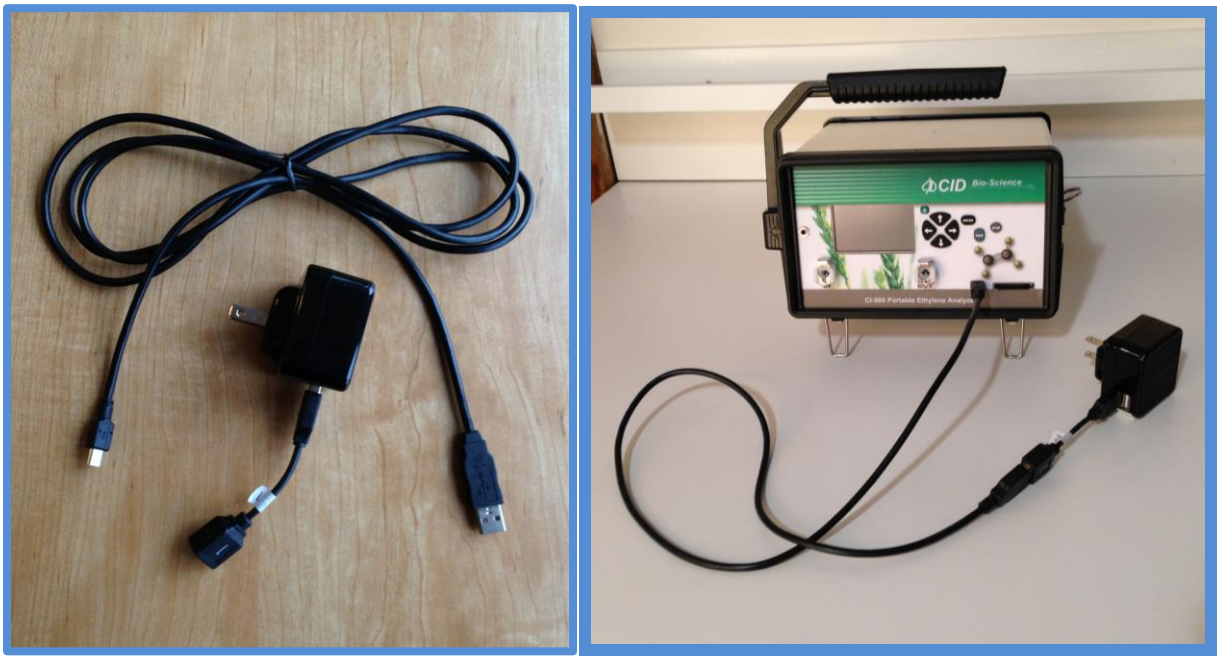


Figure 6: The battery charger setup of the CI-900.

When the instrument is connected to the battery charger, the display will remain on even when the instrument is powered off. The display will flash "powering off" on the top line when you hit the power key. "Power Off" will remain on the display until the instrument is powered back on. Remove the power cord to shut down completely.

CI-900 High resolution CO_2 Sensor and Battery Power

When the High resolution CO_2 sensor is not being actively used, it should be turned off. The CO_2 sensor draws a lot of power; if trying to conserve battery life, the sensor should be turned off when not being used. The CO_2 sensor will draw power when turned on, even if the CI-900 is not actively measuring. Turn off the CO_2 sensor when charging the unit; otherwise the recharge rate will be slow.

- Always turn the CO_2 sensor to "off" for the fastest recharge, either using the mini-USB cable and computer or with a wall charger.

To turn off/on the CO_2 sensor:

1. Go to Setup<Sensor.
2. Move down to highlight ON or OFF next to CO_2.
3. Use the RIGHT arrow key to toggle between ON/OFF.
4. Press **SAVE** when the desired setting is highlighted. This will turn off the CO_2 sensor until you come back to this menu and turn it back on.
5. If you press ENTER, the CO_2 sensor setting will only be temporarily saved. When the instrument is turned off and then back on, the CO_2 sensor will be enabled.

Taking a Measurement

Measure Menu: Sensor Stability

Create and open a file before starting a measurement (detailed instructions found on page. To begin making measurements, select the Measure Menu by pressing the RIGHT arrow key when Measure is highlighted on the Main Menu display. Make sure the IN and OUT ports on the front panel of the instrument are clear from any obstructions.

Place the fruit to be sampled in the Field Kit chamber and connect it to the unit; or, connect tubing to the "In" port and place the end of the tubing into the container or pallet to be sampled. If sampling ambient air, turn the unit on and leave it free of obstruction.

The CI-900 will display the "Sensor Stability" screen after pressing the RIGHT arrow to get into the Measure Menu. The CI-900 will begin to warm-up. The display will show the File that is open and the Flow of gas being pumped through the instrument. Below this will be whether the initialization is automatic or manual. If the initialization is automatic, the CI-900 will precede directly to the Graph Mode and Monitor Mode once the environment has stabilized. It is important to allow the electrochemical sensor enough time to stabilize or adjust to the environment that is about to be measured. If the initialization is manual, Monitor Mode will not be triggered until the user presses the right arrow to enter Monitor Mode.

- Press the DOWN arrow key to switch between automatic and manual initialization.
- Press the RIGHT arrow to skip the Sensor Stability screen and proceed to the Graph Mode display.
- Press the RIGHT arrow to enter the Monitor Mode display.
- Press the RIGHT arrow to change the Settings, turn the exterior chambers On and Off, or to close the loop (valves) and clean the sensor and tubes.
- Press the LEFT arrow to exit back to the Main Menu.

Graph View

Graph View will be entered automatically when the unit has stabilized in Sensor Stability mode. Or to enter Graph View, press the RIGHT arrow when the CI-900 is in Sensor Stability Mode. This view graphically displays the measured C_2H_4 value over time. To exit Graph View and move into Monitor Mode, press the right arrow.

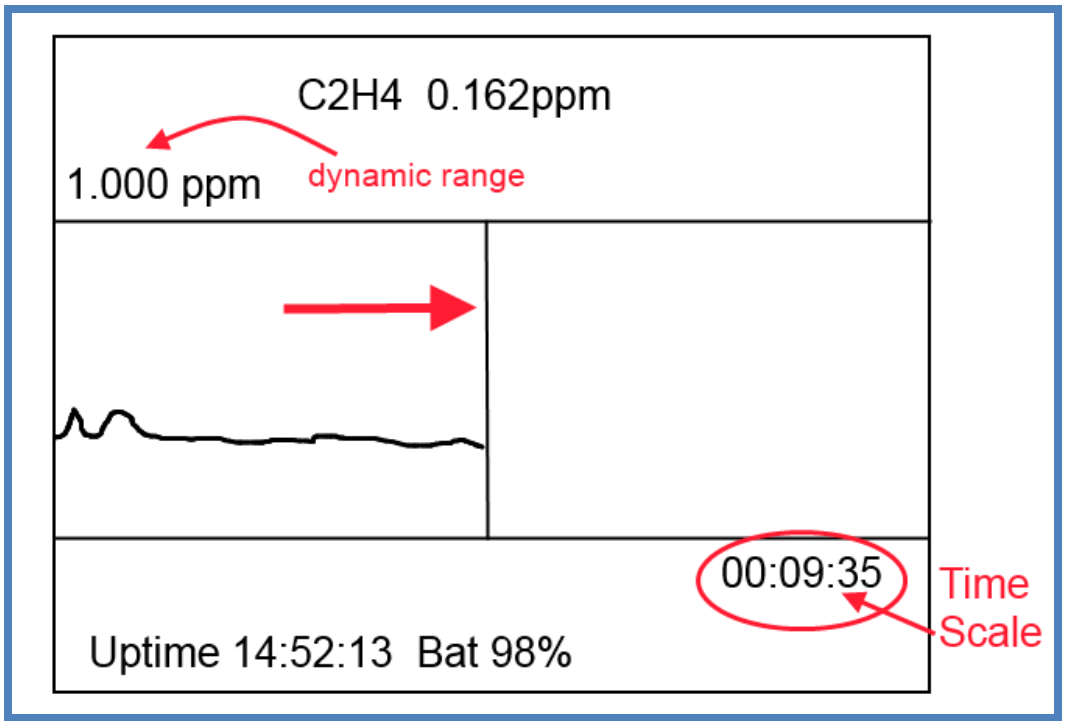


Figure 10: Display shot of Graph View with additional labels.

The top line of the display indicates the current ethylene value. Below that is the dynamic range (here it is 1.000 ppm). The y-axis scale is set by the highest value shown in the buffer. This range will scale vertically, dependent on the highest concentration of ethylene measured. If the concentration is small, the dynamic range will reflect this. For example, the initial value was 0.162 ppm and there is a sudden peak to 7.578 ppm. As the spike or peak occurs, the graph will scale to 10.000 ppm. If the sample returns to 0.168 ppm, the scale will remain at 10.000ppm until the graph and the buffer are cleared.

The scale of the graph can be increased or decreased by using the up and down keys. Pressing the up arrow will zoom in on the data, minimizing the visible range. Using the down key will increase

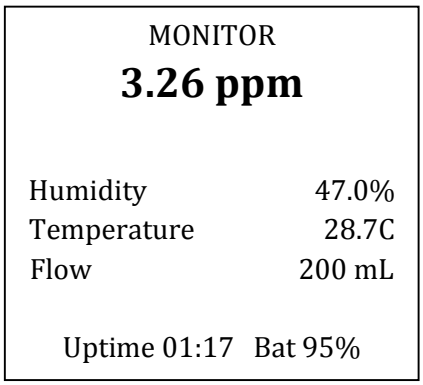
the scale, up to 20 ppm. Note that the minimum range of data visible (down to 0.100 ppm) depends on the current data being graphed. For example, if the current data is 3.486 ppm, the user may use the up key to zoom in to the 5 ppm range, but cannot zoom in to a narrower 2 ppm range.

The graph begins on the left side and moves with the vertical line towards the right as more data points are added. Once the time line reaches the right side of the display, the data will be compressed to the far left. The graph refreshes every 1 hour.

The time scale relates directly to the vertical position line. In other words, the line moves to the right as new data points are added. Every time a data point is added, the time scale is incremented. For time under 10 minutes, the graph is updating almost every second.

The bottom of the display shows the uptime of the CI-900 and current battery level.

Monitor Mode



The large bold value on the top line is the digitally filtered value of the raw ethylene measurements. The ethylene value may appear noisy, so using the filtered value helps stabilize the concentration value. Next, the HUMIDITY, or relative humidity in percent, of the gas stream in the instrument is displayed followed by the TEMPERATURE in degrees. The FLOW in mL per minutes is displayed. The calibrated, recommended flow rate is 200 mL per minute. If the unit has a high resolution CO_2 sensor on board, the CO_2 value in ppm will be displayed below the ethylene value. If the unit has a low resolution CO_2 sensor, or O_2 sensor on board, the value will be displayed in percentage (%). If the unit is equipped with a low resolution ethylene sensor, the value will continue to be displayed in large, bold font, but the range will be extended up to 100 ppm.

- If Autosave is enabled, "saved" will flash at the top of the display each time the data is automatically saved to the file.
- Press SAVE to save the currently displayed data to the SDcard. "Saved" will briefly flash on the top of the display.
- Press the LEFT arrow or STOP key to stop the measurement and exit to the Sensor Status display.
- Press the DOWN arrow to enter GRAPH Mode.

To use the CI-900 in Monitor Mode to continuously monitor fruit storage rooms or other locations, or to run the instrument for days or weeks at a time, connect the mini-USB cable to the charger cable and to the connection port on the front panel. Plug the charger into an electricity source.

Measurement Settings

The Settings screen is accessed by using the RIGHT arrow from Monitor Mode, and provides a short list of variables which may be manipulated while measurements are being made.

From the Settings screen, the exterior Inbound and Outbound Chambers are turned On/Off, valves are closed causing gas to circulate internally (Closed Loop On/Off), or the value displayed by the unit is set to zero. The function of the various applications are discussed in detail in the "Setup Menu" portion of the manual.

Hot Keys

In Monitor Mode a number of hot keys, or shortcuts, to measurement filter and cleaning features are available. The function of the various applications are discussed in detail in the "Setup Menu" portion of the manual. For quick reference, the hot keys are listed below.

Chamber In On/Off: LEFT and DOWN arrows simultaneously. Includes or does not include Chamber In (B) as a part of the measurement sample stream.

Chamber Out On/Off: RIGHT and DOWN arrows simultaneously. Includes or does not include Chamber Out (A) from flow path.

Closed Loop Cleaning: UP and DOWN arrows simultaneously. Closes inlet and outlet valves, recirculating air within the system to purge the sample stream of any interfering gases. If Chamber In or Chamber Out are selected, they will be included in the closed loop gas stream.

Electrochemical Sensor Response

The lag in sensor response is a natural phenomenon for charged porous membrane electrodes. The platinum electrode can be thought of as a series of cylindrical pores. Each of these pores will have a double layer in the radial direction. The interactions between the molecules, convection from air movement, electric fields and the concentration gradient result in a lag following a change in concentration[1].

Auto-Escape Feature

An upper limit auto-escape feature acts as a safety feature of the unit. This safety feature is always on. If the sensor detects over 20ppm ethylene, the CI-900 will auto-escape from monitor mode to prevent poisoning of the electrode. This will stop the measurement. If the sensor becomes poisoned, it will continually auto-escape with the error message "sensor out of bounds". If this happens, please consult the Setup Sensor Voltammetry section on page 21.

No SDcard Present

If the autosave is enabled and no SDcard is present, the user will be notified by seeing “NO SDCARD” on the Sensor Status display where the FILE and filename usually are. In order to continue measuring without an SDcard, the user must press **Enter** at the warning screen. Pressing any other button will return to the main menu. Each time the CI-900 tries to autosave, the unit will flash “write error” instead of “saved” at the top of the display.

[1] Kontturi et al., “Ionic Transport Processes: In Electrochemistry and Membrane Science.” (Oxford University Pess) 2008

Field Mode

To use the CI-900 Field Kit in the field or laboratory, attach the hoses of the chamber wand to the IN and OUT ports on the front panel. Slide the end of the wand into the chamber and tighten the thumb-screw. Make sure the connection is snug. The fans inside the chamber will begin to spin when the connection is established. The chambers available with the field kit are 2L or 4L. The chamber has a slit to allow for non-destructive sampling. A fruit that is still connected to the plant can be passed through the slit and then closed in the chamber. This allows ethylene levels to be recorded during ripening without damaging the fruit. Leaf chambers available for the CI-340 Photosynthesis System are compatible and interchangeable with the CI-900 Field Kit.

To sample a fruit:

- Open a data file to save the measurements to.
- Attach the chamber to the CI-900 by screwing on the wand to the top of the chamber.
- Next, connect the IN/OUT gas tubing to the ports on the front of the CI-900.
- Connect the black power chamber cable to the left of the display.
- Place the fruit inside the chamber and close it.
- Observe and record the rate of change of ethylene over time with the CI-900 Monitor Mode.

Figure 9: Attaching the fruit chamber to the CI-900 (left) and the fruit chamber power connection and gas IN and OUT on the CI-900 front panel (right).

If the tube is removed from the OUT port, ambient air will be used to replenish the fruit chamber.

Setup Menu

The CI-900 has a number of utility functions that allow the user to manage the instrument's capabilities. These functions are accessed by pressing the RIGHT arrow when Setup is highlighted on the Main Menu. The setup utility options are: Measure, Autosave, Sensor, Time, Flow, Chamber, Terminals and Board. Use the UP/DOWN arrows to select the desired option and then press the RIGHT arrow to enter the choice. Press the LEFT arrow to exit to the Main Menu.

Setup Menu
Measure
Autosave
Sensor
Calibration
Time
Flow
Chamber
Terminals
Board

Setup Measure

The Setup Measure menu allows the user to setup a measurement in 1 of 2 different modes: Monitor Mode or GC Emulation Mode. Instructions to use Monitor Mode are found in a separate section in this manual. GC Emulation Mode is only available with the CI-900 field kit

Setup GC Emulation Mode

To use the CI-900 to analyze a small sample in a syringe, the GC Emulation Mode should be used. With the simple addition of our inline injection port, small volumes of analyte can be accurately measured.

The GC emulation mode employs a patent pending Flow Inject Analysis method to determine ethylene concentrations ranging from 0.5-200ppmv with sample volumes from 3-13mL. Just like a GC a simple estimation, accurate up to +/-0.1ppmv, is made by comparing the area counts of the unknown sample to a known concentration. As shown by Equation 1, the injection volume is determined by the expected concentration of ethylene and the detection limits of the sensor. If interfering gases are expected, their expected concentrations must be added to the expected ethylene concentration.

Equation 1: $$0.2ppmv \geq \frac{Injection\ Volume * Expected\ Ethylene\ Concentration}{30mL} \geq 20ppmv$$

Exceeding the lower limit of Equation 1 will decrease the accuracy and precision of the result. Exceeding the upper limit will affect the sensitivity of the instrument and will cause the instrument to under-estimate measurements for up to 24 hours. A new calibration point may be required.

How GC Emulation Works

The patent pending Flow Injection Analysis method integrates the signal from the ethylene sensor for 300 seconds. The resulting value, reported as area counts, is then compared against a user-definable calibration point and an estimated concentration is determined. The user-definable calibration point should be determined on a technician by technician basis as injection technique will alter the result. Additionally, setting the calibration point near the expected ethylene concentration will provide the most accurate estimation.

Improvements Compared to a Gas Chromatograph

1. No need for consumable bottled gases (N_2, H_2, air).
2. Portable.
3. No heating or ovens required.
4. Predicts ethylene concentration without chromatography.

GC Emulation Mode Operation:

1. Turn on GC Emulation mode in the Setup<Measure menu.

Setup	Measure
Mode	GC Emulation

2. Enter the measure menu and wait for the instrument to stabilize.

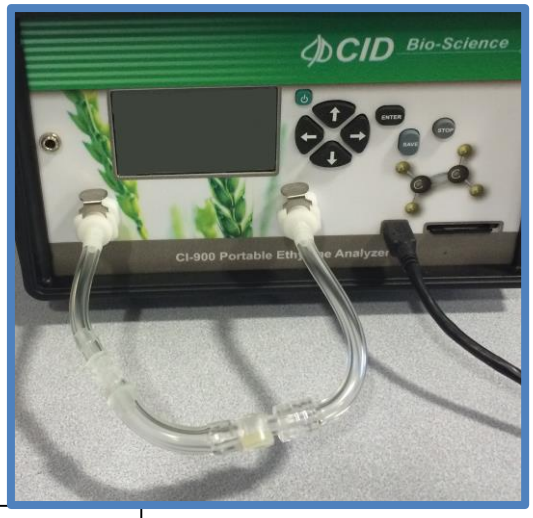
SENSOR STABILITY

File	file01
Flow	200 mL
Initialization	Automatic

Environment Stabilizing
Please Wait...42%

Uptime 00:11 Bat 98%

3. Connect the inline injection port.



4. Fill the sample syringe with analyte.

5. When prompted, inject the sample and then press Enter.

Setup injection tube then press Enter
Uptime 00:13 Bat 98%

6. Wait 300 seconds (5 minutes) for results.

initial ADC	1609543
current ADC	1609383
peak ADC	1609616
area counts	5216.2
integration time	218
Humidity	75.6%
Temperature	30.1C
Flow	200mL
Uptime 00:40 Bat 90%	

7. Press Stop to see ethylene value in ppm on display.

initial ADC	1609543
current ADC	1609383
peak ADC	1609616
area counts	33.5
integration time	218
1.2ppm	
Uptime 00:40 Bat 90%	

Setting GC Emulation Mode Calibration:

1. Take 3 measurements of a calibration gas standard.

2. Determine the average of the 3 area counts.

3. Set the value in area counts and ppb in the calibration menu. (Setup > Calibration > (Press Enter to continue) > C2H4 > Standard > Injection parameters)

Injection parameters	
area counts	0001000
concentration	0001000

Setup Autosave

To select the Autosave feature, press the RIGHT arrow key when Autosave is highlighted. This allows the user to setup the instrument to automatically store measurements, and to start a new measurement without explicitly saving the old one. This mode is convenient when taking fast, repetitive measurements, as well as when it is not necessary to review each measurement immediately after taking it. The files created by the CI-900 are saved in .csv (comma separated value) format, to be opened with Microsoft Excel or other spreadsheet program.

In the *Setup Autosave* menu, the top line of the display will read "enter" and "save" and the directional arrows. Next to is Autosave and "Yes" or "No" indicating whether this feature is turned on or off. Below Autosave is the "Interval" option where the user can set the time interval. This is the length of time in seconds between saves, when the autosave feature is selected. The default autosave interval is 10 seconds.

Autosave	Menu
<enter> <save>	←→↑↓
Autosave	No
Interval	010

- To set the instrument up to automatically store measurements press the RIGHT arrow key to highlight the word "no" on the display, then press the UP/DOWN arrow to switch to "yes". Press the SAVE key to save the configuration. After saving, it will exit to the Setup Menu.
- To set the instrument up to **not** automatically save measurements, toggle the UP/DOWN arrow key until "no" is on the display, then press the SAVE key to save the configuration.
- When Autosave is highlighted, press the UP/DOWN arrow to get to the Interval line and then use the RIGHT arrow key to highlight the time interval value. Press the UP/DOWN arrow key to change the time interval. Press SAVE to save changes.

- To avoid changing any configuration, press the STOP key to exit back to the Setup Menu.

Setup Sensor

The Setup Sensor Menu has three options, **Sensor Selection**, **Sensor Voltammetry** and **Closed Loop Cleaning**. Sensor Selection allows the user to turn on/off different sensors of the CI-900. Not all units are built with all sensors, so see the Production Check Sheet at the end of the manual to see which sensors are included in your unit. All units are equipped with a Standard, High Resolution C_2H_4, ethylene sensor. Optional sensors available are Extended Range C_2H_4 (ER), IRGA CO_2 and Extended Range (ER) CO_2 (carbon dioxide), and O_2 (oxygen).

Sensor Selection: Press the RIGHT arrow when Sensor Selection is highlighted to see the list of sensors.

Setup	Sensor
C_2H_4 STD	On
C_2H_4 ER	Off
CO_2 IRGA	Off
CO_2 ER	Off
O_2	Off

- Use the UP/DOWN arrows to select the sensor to adjust and then the LEFT/RIGHT arrow keys to switch between columns. Once in the column with the On/Off, use the UP/DOWN arrow to turn the sensor On/Off.
- If sensors are not included in your instrument, please set them to "Off".
- If not actively using the CO_2 sensor, set it to "Off" to conserve battery life.
- Press SAVE to save any changes.
- Press STOP to exit to the Setup Menu.

Sensor Voltammetry should only be used if instructed by a CID technician.

This is the electrode recovery mode and is a useful tool if the electrochemical cell has been poisoned. However, running Sensor Voltammetry may cause the calibration to shift, changing the data displayed on the screen.

During this process the pump will be turned off and a series of voltages changes will occur on the sensor. First, voltage changes serve to oxidize anything on the electrode, followed by reduction and finally, a re-stabilization period for the sensor. The cleaning will take about 40 minutes to complete, and the sensor may be very sensitive and noisy for a period of time following the cleaning.

If Sensor Voltammetry is selected by mistake, please press the STOP key to exit, as instructed on the display.

Closed Loop Cleaning closes the inlet and outlet valves on the instrument and recirculates the internal gases within the unit. This is useful for purging the cell of high concentrations of C_2H_4 and can be used when moving from a high to low C_2H_4 environment. A screen similar to the Monitor Mode screen will appear, but the CI-900 is cycling through the air inside the unit and is not be sampling the incoming air. Press stop to exit this mode and return to the Setup Sensor Menu. If Chamber A or B have been selected in the setup menu, or during measurements in Monitor Mode, then they will be included in the closed loop cleaning process.

Closed loop cleaning can also be accessed from the Monitor Mode screen by pressing the UP and DOWN arrows simultaneously. If initiated using these hot keys, the screen will stay in Monitor Mode, but the unit will read “close loop” at the bottom of the screen, indicating that the inlet and outlet valves are closed.

Setup Calibration

Current Calibration Parameters and re-calibration steps for C_2H_4, CO_2, and O_2 sensors can be found in the Calibration Menu.

C2H4 Calibration

****Re-calibration or changes to any of the Calibration Parameters for C_2H_4 must be performed under the supervision of a CID Technician only.****

Calibration Parameters are set by a CID Technician during factory calibration and are specific to each instrument. The internal offset is the ADC voltage output from the sensor when no ethylene is present, and gain is a measure of the ADC voltage output from the sensor in the presence of ethylene. The RH and T slope and offset are applied to the ADC voltage to correct for shifts in relative humidity and temperature that may occur during the sample period.

Calibration	Parameters
Internal offset	
Internal gain	
Calibrated RH	
Calibrated t	
RH slope	
RH offset	
t slope	
t offset	

Offset Autocorrection

Offset autocorrection allows the unit to adjust the baseline, or zero, for the ethylene sensors, which may drift from the zero set at the time of calibration. The most recent adjustments to the offset of the high resolution and low resolution sensors, and the gain of the high resolution sensor, are visible in this menu. The offset autocorrection procedure typically takes about 20 minutes and takes place during "Sensor Stability", the first screen when measurement mode is initiated. The default interval between autocorrections is 24 hours for continuous use, or during the next start-up for units that are not run continuously. If the unit is exposed to concentrations greater than 10 ppm during the measurement period, the offset autocorrection will be initiated the next time the user enters "Sensor Stability", even if less than 24 hours have passed.

Adjust enable: If "Yes" is selected, the unit will automatically adjust the offset every 24 hours or upon startup if more than 24 hours has passed between uses. The offset will be corrected when the user first enters measurement mode and is in the "Sensor Stability" screen. The offset autocorrection procedure typically takes about 15 minutes. To enable the automatic offset adjustment, and to ensure that the latest offset adjustment so that the unit is using the most recent zero, change the "Adjust enable" line to "Yes". To return to factory calibration parameters, select "No".

Requesting: If "Requesting" is reading "No" while adjust enable is on, the unit has recently set the offset and will not enter the offset autocorrection the next time the "Sensor Stability" screen is entered. If "Requesting" reads "Yes", the unit will begin resetting the offset the next time measurement mode is initiated and "Sensor Stability" is entered.

The offset autocorrection interval can be changed from 24 hours (default) to any user selected interval.

To manually initiate the offset autocorrection, scroll down to "manual" and press enter. This will reset the zero for the instrument any time it is engaged.

Offset	Autocorrection
Adjust enable	Yes
Hires offset	1919652
Lores offset	54782
Hires gain	302.4
Requesting	No
Interval	24
Manual	

CO_2 Calibration

To access the Calibrate CO_2 feature of the CI-900, press the RIGHT arrow key when Calibration is highlighted on the Setup Menu. Press enter to continue to the Calibration mode.

The CO_2 sensor (IRGA or ER) needs to be enabled in the SETUP<SENSOR menu to access the SETUP<CO_2 menu. To calibrate the IRGA CO_2 sensor, 400 ppm or 600 ppm standard CO_2 gas is recommended. To Calibrate the Extended Range CO_2, 4% CO_2 is recommended.

Calibration Parameters will display the coefficients from the previous calibration.

Re-Calibration allows the user to re-calibrate the sensor, setting a new zero and span for the selected sensor. IRGA CO_2 Re-Calibration is recommended weekly. Extended Range CO_2 Re-Calibration is recommended monthly. However, if the unit is in an environment where the temperature fluctuates frequently, re-calibration may be necessary more often than the recommended intervals.

Turn the ethylene (C_2H_4) sensor on for the CO_2 calibration. Directions for using a buffer system in place of a standard gas may be found at the end of the section.

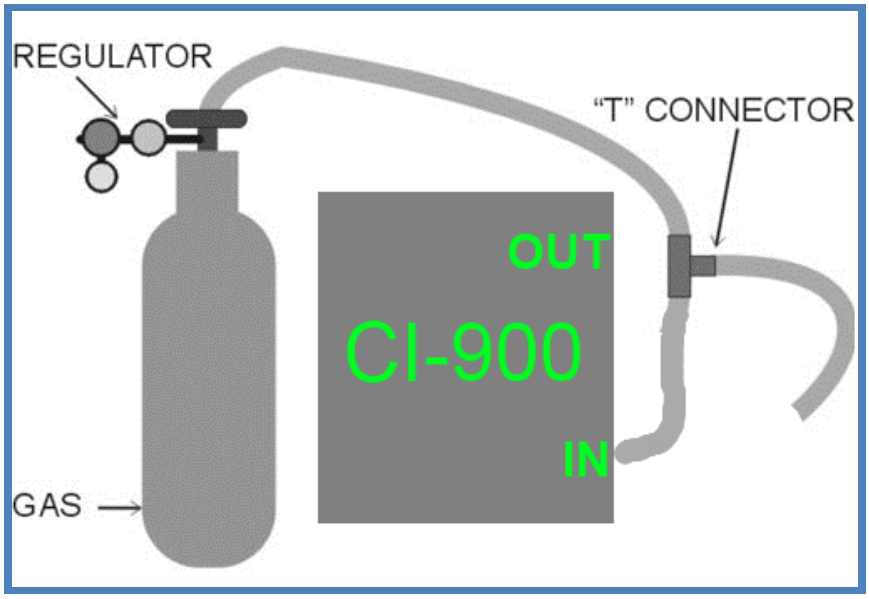


Figure 11: Calibrating the CO_2 sensor using standardized gas.

The IRGA CO_2 zero calibration will drift with time and temperature therefore weekly calibration is recommended when using the IRGA CO_2 sensor. The CO_2 span calibration should be performed immediately after the CO_2 zero calibration. When performing the CO_2 span calibration, use

standardized gas with at least 100 ppm CO_2, but not over the range of the CO_2 sensor (2000 ppm or 3000 ppm, check the production test check sheet at the end of the manual for CO_2 sensor information). The recommended standard gas concentration for the high resolution CO_2 sensor is between 400 and 600 ppm. The recommended concentration for the low resolution CO_2 sensor is 4% CO_2.

Calibrating the CO_2 sensor with standardized gas is fairly simple. **Remember, to always use a "T" connection to vent excess gas and prevent damage to the internal components.**

1. Go to Calibration, hit enter, then CO_2.
2. Go to Re-calibration and press the right arrow. You will hear the valves open and the pump begin to run.
3. Use pressurized N_2 or use soda lime and ambient air to create zero CO_2 gas. When the gas is flowing or being drawn into the unit, press Enter.
4. The unit will count down from 49 (HIRES) or 99 (LORES) as it sets the zero for the CO_2 sensor. The humidity, Temperature, and Flow are displayed. The flow should continue to read 200 mL throughout the calibration- if it does not you may have a leak or obstructed tube. (Pressing enter at any time will move you into the next step. Only do so if you want to use the previous zero calibration).
5. Setup Calibration gas: HIRES: Enter the concentration (in ppm) LORES: Enter the percent concentration. Use the LEFT/RIGHT arrow keys to switch between placeholders, and the UP/DOWN arrows to change the values.
6. Press save to initiate the calibration.
7. The unit will count down from 49 as it sets the span for the CO_2 sensor. (Pressing enter at any time will move you into the next step. Only do so if you want to use the previous span calibration).
8. After the unit has set the zero and the span for the CO_2 sensor, the Calibration Results are displayed. Press Save to save the values and return to the Calibration Menu.

Calibration Results	
zero	0
span	(600) 0000

If access to standardized CO_2 gas is limited, ambient air can be used to calibrate the High Resolution CO_2 span. Ambient air should only be used if a buffer tank system is implemented. The buffer tank system will help stabilize fluctuations in CO_2 levels, providing an ambient air with approximately 400 ppm CO_2 (depending on proximity to urbanized areas).

Tips for Calibrating the CI-900 CO_2 Sensor with a buffer system:

- The operator should stand away from the CI-900.
- Use extra tubing to get the intake source away from human breath.
- Use a buffer tank system to stabilize the intake source.

CO_2 Span Buffer Tank System Instructions

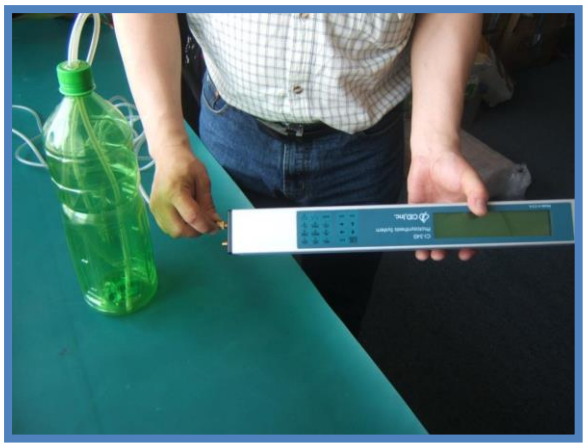
1. Find and clean an empty bottle with cap, which is at least 3L in volume.
2. Drill two small holes in the cap of the buffer bottle: 1 hole is for the intake tube and 1 hole is for the out tubing.

3. Insert a short plastic tube into the cap of the buffer bottle for the "out".

4. Insert a longer plastic tube into the cap of the buffer bottle that will connect to the “IN” of the instrument. Use hot glue or otherwise seal the tubing to the cap, with no leaks.

5. Make sure that the tube and cap has no leaks.

6. Connect the “in” tubing to the intake port on the instrument.



7. To use the buffer bottle, make sure that the tubing is clear from obstruction. Connect the In tubing to the unit. Place the buffer bottle in a location that has stable CO_2 concentration (away from operator, cars, furnace, photosynthesizing plants). Here, ambient air CO_2 levels should be approximately 400 ppm.

Note: The instrument shown in these images is a CI-340 Photosynthesis Analyzer. The buffer tank system technique can be used to help stabilize the ambient intake of any IRGA CO_2 sensor (images courtesy of ZealQuest, China).

O_2 Calibration

The offset and gain from the previous calibration can be seen under Calibration Parameters. These values are achieved by setting a zero and a span for the unit. To re-calibrate, pressurized N_2 gas and O_2 gas will be needed. If O_2 gas is not available, ambient air may be used. Monthly Re-Calibration is recommended, but if the environment changes frequently, re-calibration may be required more often.

Calibrating the O_2 sensor with standardized gas is fairly simple. **Remember, to always use a "T" connection to vent excess gas and prevent damage to the internal components.**

1. Go to Calibration, hit enter, then O_2.
2. Go to Re-calibration and press the right arrow. You will hear the valves open and the pump begin to run.
3. Use pressurized N_2 to create zero O_2 gas. When the gas is flowing and connected to the unit, press Enter.
4. The unit will count down from as it sets the zero for the O_2 sensor. The humidity, Temperature, and Flow are displayed. The flow should continue to read 200 mL throughout the calibration- if it does not you may have a leak or obstructed tube. (Pressing enter at any time will move you into the next step. Only do so if you want to use the previous zero calibration).
5. Setup Calibration gas: Enter the percent concentration, where 1000 E-3 = 100% and 210 E-3= 21%. Use the LEFT/RIGHT arrow keys to switch between placeholders, and the UP/DOWN arrows to change the values.
6. Press save to initiate the calibration.
7. The unit will count down from 19 as it sets the span for the CO_2 sensor. (Pressing enter at any time will move you into the next step. Only do so if you want to use the previous span calibration).
8. After the unit has set the zero and the span for the CO_2 sensor, the Calibration Results are displayed. Press Save to save the values and return to the Calibration Menu.

Setup Time and Date

To change the time and date on the CI-900, press the RIGHT key when "Time" is highlighted on the Setup menu. This utility allows the user to set-up the instrument in different time zones or to adjust the time after daylight savings.

- To change the time on the instrument, use the UP/DOWN arrows to change the values. Use the LEFT/RIGHT arrow to highlight the appropriate column. Then, make the appropriate shift in time and press SAVE.

Setup	Time
03 28 2013	16 : 33 : 24

Setup Flow

The air flow of the CI-900 is an important factor for taking good measurements. The default, recommended flow rate is 200 ml/min. Varying the flow rate from 200 ml/min may affect the calibration and increase error.

The flow value on the Sensor Status screen should be between 150-350ml/min. A flow value below 100 ml/min can negatively impact sensor functionality. If measuring bottled gas, a lower flow rate may be used in order to reduce gas waste. If measuring open air, a higher flow rate (~300 ml/min) is acceptable. The default, recommended flow rate is 200 ml/min.

Setup	Flow
Set Flow	200
Actual Flow	200

To make adjustments:

1. Go to Setup<Flow and press the RIGHT arrow.
2. Use the UP/DOWN arrows to adjust the value.
3. The Set Flow value is found in ml/min to the far right.
4. The Actual Flow value will change to match the set flow.
5. Press SAVE to save changes and exit back to the Setup Menu.
6. Press STOP to exit back to the Setup Menu without saving.

Setup Chamber

To access the Setup Chamber feature of the CI-900, press the RIGHT arrow key when Chamber is highlighted on the Setup Menu. Here, the user can turn on or off the in-line conditioning columns on the back of the instrument. These removable plastic containers are used to hold the consumables soda lime, silica gel, potassium permanganate and distilled water. The purpose of the inbound chamber, Chamber_In (B) is to either condition the air before it reaches the sensor or provide a "special mode" where distilled water is used to filter out alcohols before the electrochemical sensor. The purpose of the outbound chamber, Chamber_Out (A) is to condition the air going back into the fruit chamber or room and occurs after the sensor. Place the empty chambers back on the instrument before taking measurements. If Chamber_In or Chamber_Out are selected when the unit enters Closed Loop Cleaning then they will be included in the cleaning loop (v006 Hardware). In units with v005 hardware, only the inbound chamber, Chamber_In, is included in a closed loop.

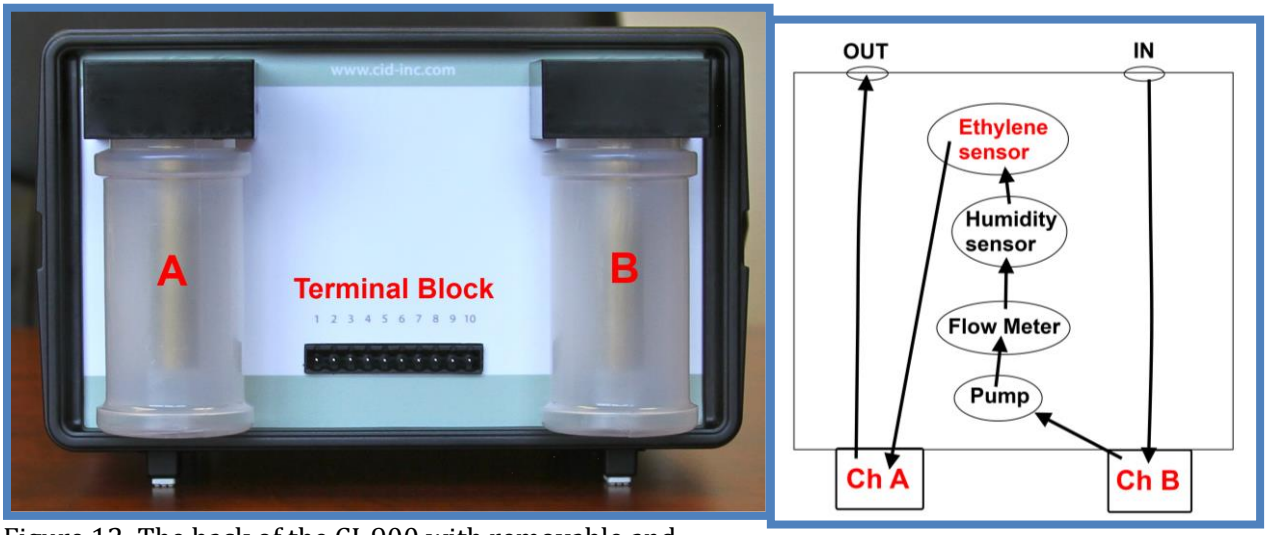


Figure 12: The back of the CI-900 with removable and refillable containers for consumables (left) and a diagram showing the flow path of the gas stream (right).

Chamber Out (A) is on the left of the back panel. If the Outlet gas stream is connected to the field kit chamber or to the inlet of the unit, it can be used to condition the incoming gas after it leaves the sensor.

Enabling Chamber Out, the CI-900 can use soda lime to scrub CO_2 from the gas stream. Similarly, silica gel is used to scrub water from air and create a 0% relative humidity gas. Potassium

permanganate can be used to scrub hydrocarbons from the gas stream. Potassium permanganate beads (not dust) should be sourced locally by the user. The silica gel has an added color indicator that changes from blue to pink when replacement is necessary. Chamber Out (A) is the last chamber before the gas OUT port.

To use Chamber Out to condition the air replenishing the fruit chamber, enable Chamber Out in the Setup<Chamber menu and fill Chamber A with the appropriate consumable. Connect the fruit chamber hoses to both the IN and OUT ports on the front of the CI-900.

Keep the plastic containers on the CI-900, even when empty, to protect the brass intakes. Always ensure the conditioning chamber is seated properly when screwing it on the CI-900.

Chamber In (B) is on the right side of the back panel. This chamber can be enabled in 2 different modes. Chamber In can be filled with distilled water to help filter out alcohol in the air stream. By passing the gas sample through the water, polar molecules are trapped or filtered from the airstream. Using Chamber In (B) as a "bubbler" can help reduce the interference measured when alcohol or other light polar molecules (known interfering gases for the CI-900 electrochemical sensor) are present. Also, using the water trap can help keep the electrochemical cell hydrated, with longer periods of time between needing to refill the electrochemical sensor.

There are 3 options for Chamber B in the Setup<Chamber menu.

1. Chamber In set to OFF.
2. Chamber In set to ON.
3. Chamber In set to SPECIAL.

Use the UP/DOWN arrows to select Chamber Out, Chamber In or Measure or Cleaning. Then, use the RIGHT arrow to get to Off/On. Next, use the UP/DOWN arrow to switch between on or off, or set the measure or cleaning period in minutes.

Chamber	Menu
CHAMBER_A OUT	Off
CHAMBER_B IN	SPECIAL
MEASURE PERIOD	3 MIN
CLEANING PERIOD	17 MIN

To use soda lime or silica gel to condition the air stream before it is measured, turn Chamber In (B) to ON and place the consumable in the conditioning chamber.

To use the water trap or bubbler, set Chamber In (B) to SPECIAL. Fill Chamber In less than half full with distilled water. Next, set the length of the measuring period in minutes. This is the time the CI-900 will take to do a measurement. When using the water trap, a settling time of at least 3 minutes is required before being able to record a measurement. At a measuring time of 5 minutes, the reading is settled, but the overall measurement will take longer. A measuring period of 3-5 minutes is sufficient to achieve an accurate reading. After 5 minutes you run the risk of reaching saturation. Actual times will depend on application/environment.

When the CI-900 is using the water to filter out alcohol, the water must be cleaned by running a longer cleaning period than the measure period. The length of time required for cleaning will be dependent on the individual CI-900.

The main reason for the cleaning step is to keep the water in the maximum adsorption range. As the water becomes polluted with alcohols, it will not filter as effectively. This results in an increase in signal from interfering gasses escaping the filter. A small measurement to cleaning time ratio is suggested because the longer the measure time with the filter, the longer it will take to clean. A recommendation of 4 minutes of measure and 6 minutes of cleaning is better than 20 minutes of measure and 60 minutes of cleaning.

When using bubbler mode, the water level of Chamber Inbound (B) needs to be inspected every 120 hours. Bubbler mode may not be applicable at high ethylene concentrations.

When the CI-900 has conditioning Chamber Inbound (B) turned on, the Monitor Mode display will be slightly different. The top line of the Monitor display will indicate CH_IN, meaning that Chamber B is enabled. Next, the current state (measure or cleaning) will be shown. If the CI-900 is in state of Measure, the data will reflect the current measurement. If the CI-900 is in a state of Cleaning, the data will show two ethylene values, one will be the last measured value in measure period and the second will be the current value in cleaning period. The CI-900 has two hydrophobic filters in line with the internal tubing. This is to protect the CI-900 in case any water is sucked into the instrument when using the bubbler mode.

CH_IN	MEASURE
0.160 ppm	
TEMPERATURE	28.7C
HUMIDITY	47.0%
FLOW	200 mL

Hot Keys in Monitor Mode can be used to turn Chamber In an Chamber Out on or off at any point during the measurement period

Chamber In On/Off: LEFT and DOWN arrows simultaneously. Includes or does not include Chamber In (B) as a part of the measurement sample stream.

Chamber Out On/Off: RIGHT and DOWN arrows simultaneously. Includes or does not include Chamber Out (A) from flow path.

To avoid drawing water into the internal tubing of the CI-900 when using SPECIAL mode:

1. Fill Conditioning Chamber In (B) only to the fill line and never completely fill the conditioning chamber with water.
2. Always keep the top panel of the CI-900 facing up and do not tilt the instrument when there is water in the conditioning chamber. When operating in SPECIAL mode, do not operate the instrument with the display panel facing upwards.
3. Do not transport or tip the CI-900 if moisture is in Chamber In. Before transport or moving the CI-900, Chamber In should be completely dry to prevent even small drops of liquid from entering the unit.
4. If the Relative Humidity sensor reads high, open the top panel of the unit and inspect hoses for liquid. If liquid has accumulated at the hydrophobic (blue) filter, it should be disconnected and drained. If liquid has penetrated the hydrophobic filter the unit will need to be serviced to prevent circuit board failure. For instruction to open the top panel, see Refilling the Electrochemical Sensor section of this manual. Contact support@cid-inc.com with any questions.

Setup Terminals

The Setup<Terminals Menu is where the CI-900 can be setup to have an external fan or gas control connected to the terminal block. The terminal block is located between the chambers for consumables on the back panel of the CI-900. The CI-900 can turn on and off the gas or a fan based on the measured ethylene concentration of the room (or chamber). In this way, the CI-900 could be used to control a fan set to evacuate a store room if ethylene concentrations increase past a set point. Other control applications using the terminal block are possible, such as controlling ethylene scrubbers.

Setup	Terminals
VALUE	PPB
GAS_HI	00000
GAS_LO	00000
FAN_HI	00000
FAN_LO	00000
CONTROL	DISABLE

- Press the UP/DOWN arrow to switch between parameters.
- Press the LEFT arrow to switch to the column containing the values in **ppb** (parts per billion).
- Use the UP/DOWN arrow keys to set the desired level.
- Press the LEFT arrow, STOP or SAVE to exit back to the Setup Menu. Any changes made will automatically be saved.

The CI-900 will perform an action at the high and low levels, when set. If the concentration of ethylene rises above the Gas_Hi, the gas will be shut off. If the ethylene concentration is lower than the Gas_Lo, the gas will be turned on.

Similarly, the fan control is used to turn on and off a fan based on ethylene concentration. If the ethylene concentration rises above the Fan_Hi level, the CI-900 will turn on the fan in order to evacuate a room or chamber and reduce the ethylene concentration. The Fan_Lo setting is to turn off the fan. The Gas and Fan controls can be used together, but be sure that the Fan_Lo setting is well above the Gas_Hi setting.

To connect a fan or gas control to the terminal block of the CI-900, first pull off the removable portion of the terminal block (pull straight out). The piece in the figure below will separate from the CI-900. Slide the wire from what is going to be controlled through the opening for pin 4 or pin 5. Use a screw driver to tighten and clamp onto the wire, creating a connection. The removable section of the terminal block is designed to stay with the fan or gas control. So, if the CI-900 needs to be moved, the terminal block can be disconnected easily.

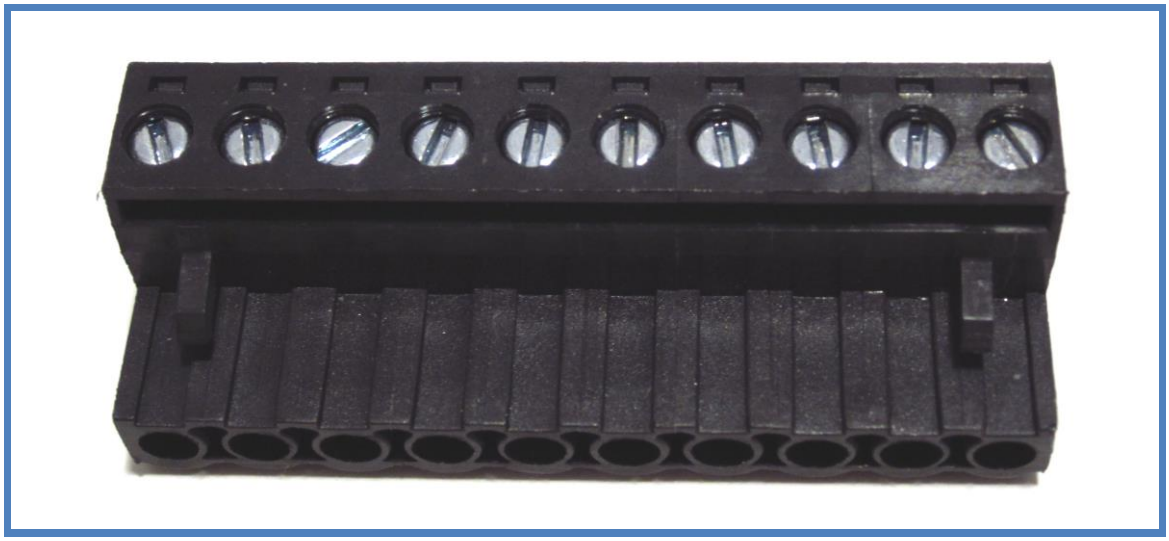


Figure 13: The removable piece of the CI-900 terminal block.

The 10 pins of the terminal block have the following designations:

PIN	Function
1 and 2	Ground
3	Plus 5 volts (limited through 4.7 ohm resistor)
4	Gas valve control (5 V)
5	Fan control (solid state relay) (5V)
6	Alarm or error indicator
7 and 8	Analog outputs
9 and 10	Analog inputs

Setup Board

The Setup Board Menu should only be changed by a CID Technician. This menu allows the user the select the type of hardware platform that the unit operates on, and should only be changed at installation, or if hardware is upgraded.

View Menu

The View Menu can be accessed from the main menu screen by pressing the RIGHT arrow key when "View" is highlighted on the display. This menu allows the user to navigate to and see the files, as well as check on many features of the CI-900. Options from the View menu are: Files, Voltage, Battery, Flash, Time, GPS, and SDcard.

View Files

The View Files menu allows the user to review the filenames and file size of any files on the CI-900. To view collected and saved data, either download files via USB or eject the SDcard and insert it in a computer. In the View Files mode, the top line of the display will show the word "View" on the left and "Files" on the right. Below this, the column of the right contains the filename and the column on the right contains the file size.

The options are:

- use the UP or DOWN arrow keys to scroll through the files
- press the LEFT arrow or STOP to exit to the View Menu

View	Files
File01	3201
RoomA2	1022
Fruit7	0

Note: A file with a negative number for the file size is corrupt. This file should be deleted and re-created.

View Voltage

The View Voltage screen shows the current voltage of the instrument. Press the RIGHT arrow when Voltage is highlighted to check the unit's voltage. If any of these numbers are rapidly changing after the instrument has warmed up, please contact technical support at support@cid-inc.com. Press the LEFT arrow or STOP to exit back to the View Menu.

Voltage is set for each individual unit before leaving the CID Bio-Science factory and is board specific. For default voltage values, please see the Production Test Check Sheet at the end of the Instruction Manual or contact support@cid-inc.com with the serial number for factory voltage settings. V_System is the voltage of the control board. The voltage for V_Charger should increase when you connect the USB charger. V_3volt is the digital voltage from the CPU and the V_Analog is the converted analog voltage.

View		Voltages
V_System	=	5.98v
V_Charger	=	4.64v
V_3volt	=	3.31v
V_Analog	=	2.07v

View Battery

The View Battery menu displays indicates on the top line if the unit's Charging is On or Off, or if the unit is connected via USB cable to a computer. Press the UP/DOWN arrow to change the display and see the more information about the battery. The QBAT value shows the battery level in hexadecimal follow immediately by the battery level in percent. VBAT shows the voltage of the battery and TBAT indicates if the temperature of the battery is ok. The R0 shows the output status of the battery charger. Press the LEFT arrow or STOP to exit to the View Menu.

Charge	Off
QBAT:	a413 60%
VBAT:	3.840V
TBAT:	OK
Charge:	Off
Board:	v6

When the instrument is connected to the charger, the top line will indicated "Charge On." The QBAT hexadecimal number should be changing and the battery percent increasing. Also, the voltage will begin to increase slowly and the R0 will switch to 1d.

The Board refers to the hardware version of the unit. Features described in this manual are associated with all versions of hardware. When discrepancies occur, they are listed, along with the version that they are associated with.

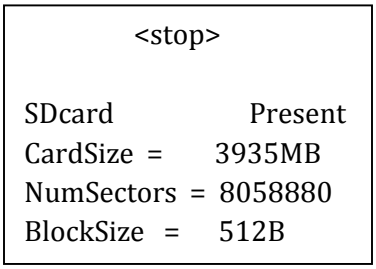
If any of these numbers are rapidly changing after the instrument has warmed up, please contact technical support at support@cid-inc.com.

Other View Menu Options

The View Flash option is only accessible by CID Bio-Science technicians.

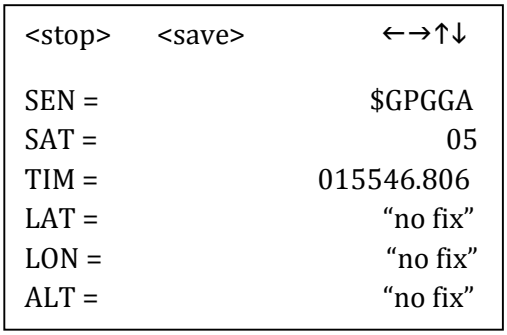
The View Time screen displays the current time on the instrument. Press the LEFT arrow or STOP to exit back to the View Menu.

The View SDcard screen indicates if an SDcard is present in the unit, as well as other information about the SDcard. If no SDcard is in the instrument, or if the SDcard is not fully inserted, "no SDcard" will appear on the display.



GPS System Features

The CI-900 has a built-in GPS system which can relay the longitude, latitude and altitude of the instrument when performing measurements. The View GPS screen displays the mode of the GPS sensor (SEN= $GPGGA), as well as the values for latitude, longitude, altitude and indicates the number of satellites currently connected to. Press the UP/DOWN arrow to display the latitude, longitude and altitude information only.



The GPS uses GMT or Greenwich Mean Time for a standardized time. The GMT is displayed as the time (TIM) on the GPS menu and is synchronized with minute and second alignment. Often, when the instrument is turned on indoors, the latitude, longitude and altitude will read "no fix. This occurs when no satellite signal can be obtained by the instrument. Powering up the CI-900 outdoors will correct this problem and allow latitude, longitude and altitude readings to be taken.

File Menu

The File Menu is accessed by highlighting "File" on the Main Menu and pressing the RIGHT arrow key. Here, the user can manipulate files on the CI-900, with options to clear, delete, create and open files.

The CI-900 uses an SDcard to store all measurements. This means the user is able to create, clear and delete any measurement file.

To view data on a computer, simply insert the SDcard into the computer's SDcard reader. The computer should automatically detect the SDcard as a new storage device and mount the drive so that measurement data will be accessible by any computer application. The mini-USB port can also be used to establish a USB connection with a computer to transfer data from the CI-900.

Clear or Truncate a File

Pressing the RIGHT arrow key when "Clear" is highlighted on the display engages the unit in the *file truncate* mode. This mode allows the erasure of the file contents without changing its name or its set-up. This feature is useful if it is necessary to do a number of similar measurements. The user can take these measurements to a particular file, copy the results, clear the file, and be ready to take a new set of measurements to that file.

Clear	File
File01	3201
RoomA2	1022
Fruit7	0

In the *file truncate* mode, the top line of the display reads "Clear" on the left and file on the right. Filenames are listed on the left and the file size is listed in the right column. An empty file will have a zero as the file size.

- Use the UP or DOWN keys to select the file to clear.
- Press the RIGHT arrow to clear the file.
- Press ENTER to confirm
- The display will indicate "Done!" when the file is erased.
- Press STOP or the LEFT arrow to go back to the File Menu.

Delete a File

Press the RIGHT arrow when "Delete" is highlighted on the display to get the unit into the *delete file* mode. This mode will erase a file (and filename) completely from the memory/SDcard. In this mode, the top line of the display reads "Delete" on the top left line and file on the right. Below this, the filename is listed on the left and the file size is listed on the right.

Delete	File
File01	3201
RoomA2	1022
Fruit7	0

- To delete a file, use the UP or DOWN arrow keys to select a file.
- Once a file is selected to be deleted, press the RIGHT arrow key to delete the file.
- Press ENTER to confirm. Or, to escape without deleting the file, press the LEFT arrow or STOP key.
- The display will indicate "Done!" when the file is erased.
- Press STOP or the LEFT arrow to go back to the File Menu.

Create a File

Press the RIGHT arrow when "Create" is highlighted on the display to get the unit into the *create files* mode. The top line of the screen will read "Name" on the left, and a file name (e.g. "file00") on the right. The bottom line will read "enter" at the left, "stop" at the center, and the left/right arrows appear at the right.

Name:	file00
ENTER TO CREATE A FILE	
STOP TO CANCEL	

NOTE: The STOP key can be pressed at any time to abort the file creation process and to return to this point.

Pressing the arrow keys will allow the user to enter an alpha or numeric selection for a six-character file name. The RIGHT/LEFT arrow keys select which character in the file name to edit and the UP/DOWN arrow keys are used to choose a character.

The chart lists the available characters. Although special characters are seen as options while creating a filename, it is currently recommended not to use special characters when naming files with firmware version 1.07. **The filename must end in a number**, or else the file will be corrupt and no data will be saved to it.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q r s t u v w x y z
0 1 2 3 4 5 6 7 8 9

Pressing the SAVE key in the "Create" mode deletes the character under the cursor. Note that characters cannot be inserted into an existing file name. Should the file name be identical to another file name, the instrument will display the message “duplicate name” on the top line of the display and “enter” on the bottom.

Fruit01	Create
<enter>	<stop>

The CI-900 will save all parameters for each measurement on the SDcard. Once finished creating the file name, press the ENTER key, or press STOP to abort the process. The CI-900 will exit to the File Menu.

Open File

Press the RIGHT arrow when "Open" is highlighted on the display to get the unit into the *open files* mode. The top line of the screen will read "Open" on the left, and File on the right. Filenames are listed on the left and the file size is listed in the right column.

Open	File
File01	3201
RoomA2	1022
Fruit7	0
Fruit9	-2

An empty file will have a zero as the file size. If the file is corrupt, the file size will be a negative number. Any file with a negative file size should be deleted and re-created. Only files with positive numbers or a zero for the file size can be opened to save data too.

- Use the UP or DOWN keys to select the file to open.
- Press the RIGHT arrow to open the file. "Done!" will flash across the screen if the file was opened successfully.
- Press STOP or the LEFT arrow to go back to the File Menu.

Note: After a file is created, it must be opened in order to start saving data to it.

Data Transfer to a Computer

To view the collected data on a computer, remove the SDcard and insert it in an SDcard reader on the computer. Or, use the supplied USB cable and connect the instrument to the USB host (computer). The user can only view/manipulate data on a computer via the USB connection, or with the removable SDcard. Data cannot be viewed after it is saved on the CI-900.

Once the instrument is connected to the computer via USB cable, it is strongly recommended that the user copy and re-save the files and images to the hard drive of the computer. The computer application used to view the files can also be used to re-save them. It is recommended that the user does not work from the original file on the SDcard after the measurement has been made, because if any changes are made to the original file, it can break the alignment of the file causing error and data loss.

In order to keep the file system in sync, perform any editing or further calculations on the copied file saved to the computer hard drive. **Do not edit the files directly on the SDcard!**

Do not connect the USB cable to the instrument and the computer while performing measurements. If the user tries to operate the instrument through the computer, the files are subject to becoming out of sync, breaking alignment and causing errors in the files. This can also lead to problems with saving data.

If an error occurs in a specific data file, it can be deleted and created again. Go to the File Menu on the instrument; clear the file where the error has occurred. If the file has been transferred to the computer, delete it on the computer also. Once the corrupted files have been deleted, create the file again (if it has been properly cleared, the same file name can be used) and re-take the measurement.

Data Files on the Computer

Open the data files saved on the SDcard on the computer using Microsoft Excel or Notepad. The figure below is an example data spreadsheet. Data values included are the date and time of the measurement, the ethylene level in ppm, the mode (monitor, measure or cleaning), the CO_2 concentration, the temperature of the gas stream in degrees Celsius, the relative humidity (RH) of the gas stream in percent and the flow rate of the gas stream in ml/min. In this example, the CO_2 sensor was not used in the example below, so the concentration values are zero.

	A	B	C	D	E	F	G	H
1	Date	Time	C2H4 (ppmv)	Mode	CO2 (ppmv)	Temp C	RH %	Flow (mL/min)
2	4/22/2013	15:15:35	2.983	monitor	0	29.8	54.6	201
3	4/22/2013	15:15:45	2.981	monitor	0	29.8	54.6	201
4	4/22/2013	15:15:55	2.985	monitor	0	29.7	54.6	201
5	4/22/2013	15:16:05	2.989	monitor	0	29.7	54.6	201
6	4/22/2013	15:16:15	2.986	monitor	0	29.7	54.6	201
7	4/22/2013	15:16:25	2.987	monitor	0	29.7	54.6	201
8	4/22/2013	15:16:35	2.989	monitor	0	29.7	54.6	201
9	4/22/2013	15:16:45	2.992	monitor	0	29.7	54.6	201
10	4/22/2013	15:16:55	2.995	monitor	0	29.7	54.6	201
11	4/22/2013	15:17:05	2.994	monitor	0	29.7	54.6	201
12	4/22/2013	15:17:15	2.993	monitor	0	29.7	54.5	201
13	4/22/2013	15:17:25	2.996	monitor	0	29.7	54.5	201
14	4/22/2013	15:17:35	2.999	monitor	0	29.8	54.5	201
15	4/22/2013	15:17:45	2.994	monitor	0	29.8	54.5	201
16	4/22/2013	15:17:55	2.994	monitor	0	29.8	54.5	201
17	4/22/2013	15:18:05	2.995	monitor	0	29.8	54.5	201
18	4/22/2013	15:18:15	2.998	monitor	0	29.8	54.4	201
19	4/22/2013	15:18:25	3	monitor	0	29.8	54.4	201
20	4/22/2013	15:22:41	3.675	monitor	0	29.6	50.4	189
21	4/22/2013	15:22:51	2.58	monitor	0	29.6	50.7	185
22	4/22/2013	15:23:01	3.566	monitor	0	29.6	50.8	194
23	4/22/2013	15:23:12	3.494	monitor	0	29.6	50.9	200
24	4/22/2013	15:23:22	2.931	monitor	0	29.6	51	201
25	4/22/2013	15:23:32	2.328	monitor	0	29.6	51	201
26	4/22/2013	15:23:42	1.859	monitor	0	29.6	51	201
27	4/22/2013	15:23:52	1.516	monitor	0	29.6	50.9	201
28	4/22/2013	15:24:02	1.26	monitor	0	29.6	51	201
29	4/22/2013	15:24:13	1.071	monitor	0	29.6	50.9	201
30	4/22/2013	15:24:23	0.921	monitor	0	29.6	51	201
31	4/22/2013	15:24:33	0.827	monitor	0	29.6	50.9	201
32	4/22/2013	15:24:43	0.742	monitor	0	29.6	50.9	201
33	4/22/2013	15:24:53	0.676	monitor	0	29.6	50.9	201
34	4/22/2013	15:25:03	0.638	monitor	0	29.6	50.9	201
35	4/22/2013	15:25:13	0.61	monitor	0	29.6	50.9	201
36	4/22/2013	15:25:24	0.566	monitor	0	29.6	50.8	201
37	4/22/2013	15:25:34	0.535	monitor	0	29.6	50.8	201
38	4/22/2013	15:25:44	0.53	monitor	0	29.6	50.8	201

Figure 14: Example data spreadsheet for a CI-900 measurement.

REMEMBER: Always save the data files to the computer before making changes or starting analysis.

FIRMWARE UPDATE

Transfer all data files from the SDcard and DELETE all data files on SDcard before doing the firmware update! Leaving data files from older firmware versions may corrupt the SDcard.

Several files should be accessed from the software CD or downloaded from the CI-900 software webpage (http://www.cid-inc.com/ci-900-software.php). Always double-check the webpage for the latest compatible firmware version depending on the serial number of the CI-900.

1. Transfer code application: DL203_900.exe
2. Firmware code file: ci-900-ver-x.xx.bin
3. Folder to create the LIBUSB driver: Install Driver

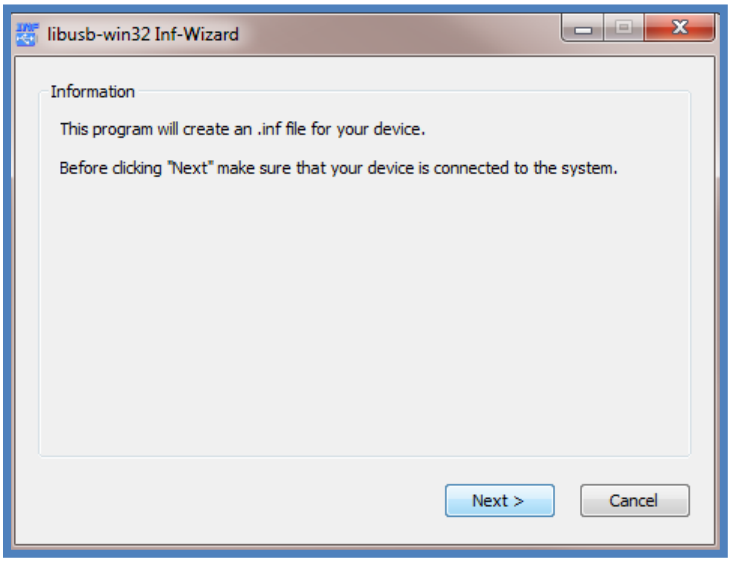
Please contact CID Bio-Science technical support with questions about firmware updates.

Procedure

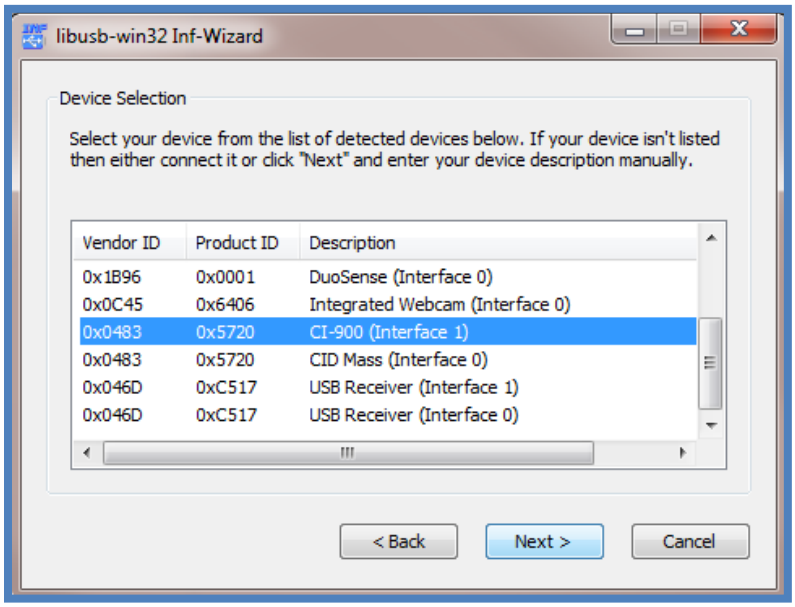
1. Connect the CI-900 to the computer using the mini-USB to USB cable.
2. Create the CI-900 driver:
    a. Open the **Install Driver** folder.
    b. Double-click on the **install_driver_inf.exe** to create and install the driver. Make sure the CI-900 is connected to the computer and powered on.

c. Follow the prompts in the libsusb-win32 Inf-Wizard.

i. Click Next after making sure the device is connected to the system.

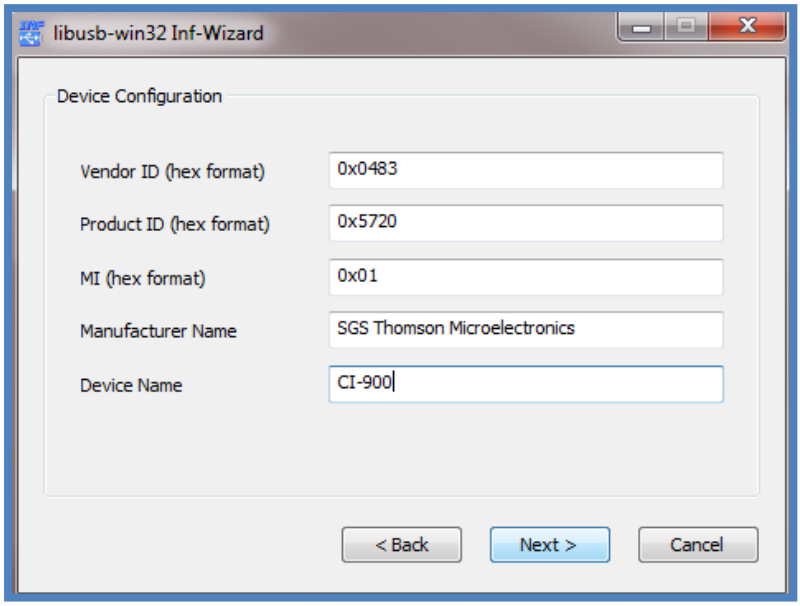

libusb-win32 Inf-Wizard
Information
This program will create an .inf file for your device.
Before clicking "Next" make sure that your device is connected to the system.
Next >
Cancel

ii. Select the CI-900 from the list. It may not be called the CI-900. The vendor ID is 0x0483 and Product ID is 0x0572


libusb-win32 Inf-Wizard
Device Selection
Select your device from the list of detected devices below. If your device isn't listed then either connect it or click "Next" and enter your device description manually.
Vendor ID
Product ID
Description
0x1B96 0x0001 DuoSense (Interface 0)
0x0C45 0x6406 Integrated Webcam (Interface 0)
0x0483 0x5720 CI-900 (Interface 1)
0x0483 0x5720 CID Mass (Interface 0)
0x046D 0xC517 USB Receiver (Interface 1)
0x046D 0xC517 USB Receiver (Interface 0)
< Back
Next >
Cancel

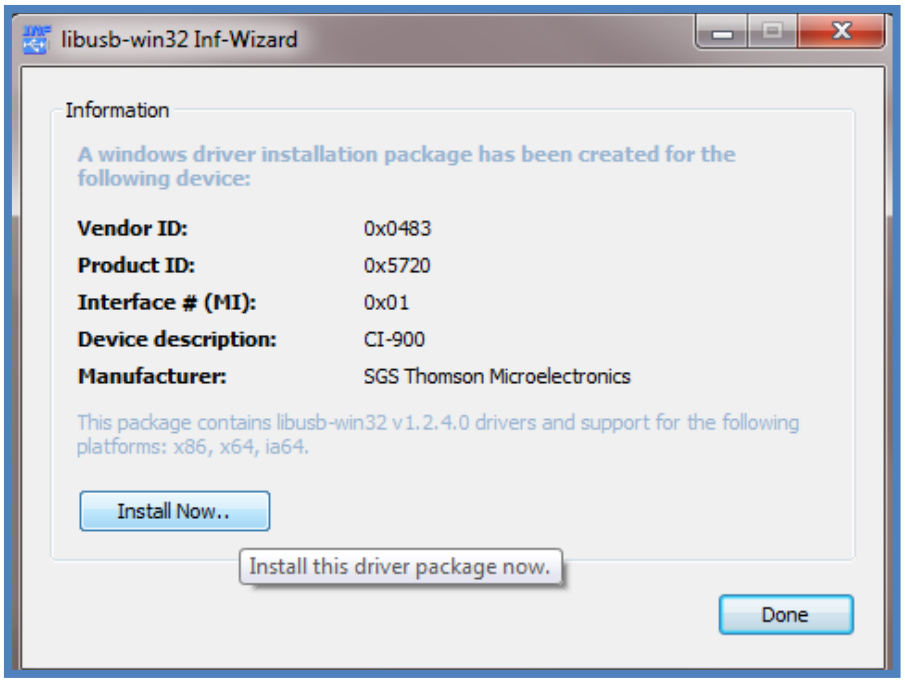
iii. Click Next.

iv. Re-name the Device Name to CI-900 and click Next.



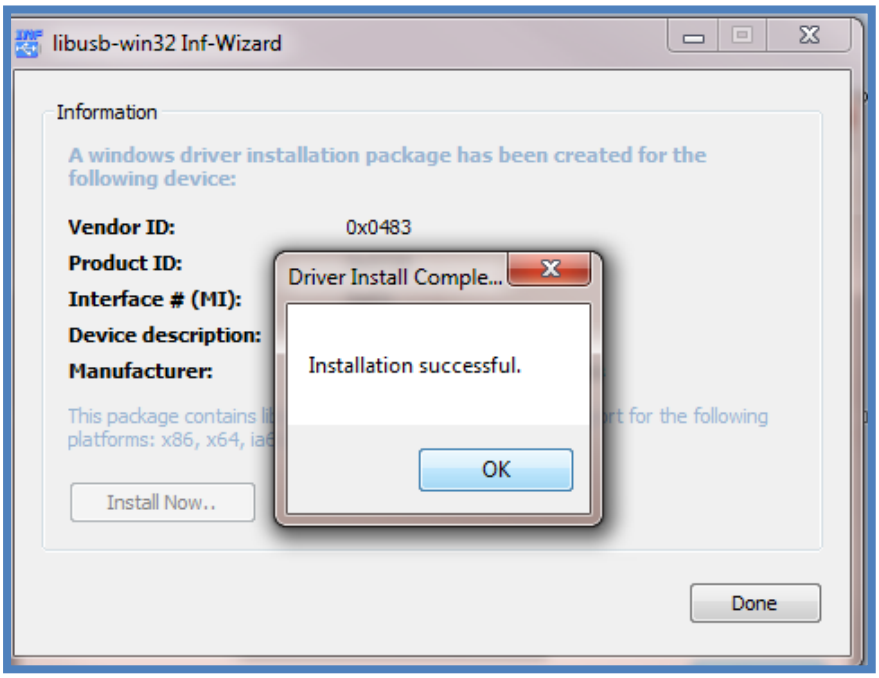
v. Save the .inf file and remember where.

vi. In the libusb-win32 Inf-Wizard, click the Install Now button.


libusb-win32 Inf-Wizard
Information
A windows driver installation package has been created for the following device:
Vendor ID: 0x0483
Product ID: 0x5720
Interface # (MI): 0x01
Device description: CI-900
Manufacturer: SGS Thomson Microelectronics
This package contains libusb-win32 v1.2.4.0 drivers and support for the following platforms: x86, x64, ia64.
Install Now..
Install this driver package now.
Done

vii. If Windows can't verify the publisher of the driver software, click to Install this driver software anyway.

viii. Click Ok after driver installation is successful.



3. After installing the driver, open the **900 Firmware** folder.

4. Open the **DL203_900.exe** "Transfer Code to CI-203 or CI-900" application.

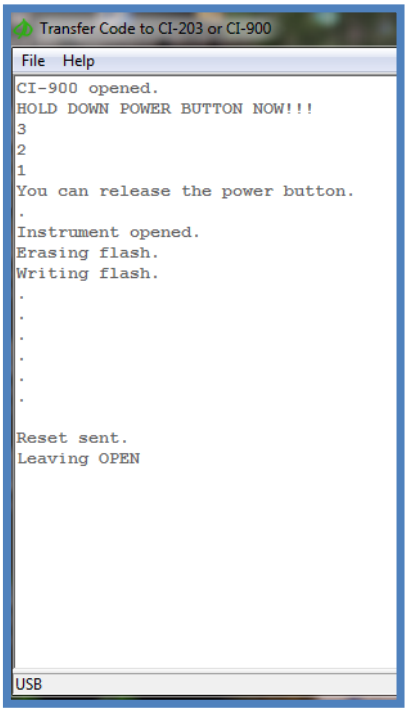
5. Select File and Open.

6. Navigate to the **ci-900-ver-x.xx.bin.** This is the code for the instrument. The .bin file should be located in the same folder as the DL203_900.exe.

7. Follow the instructions in the software to hold down the power button.

8. Release the power button when instructed.

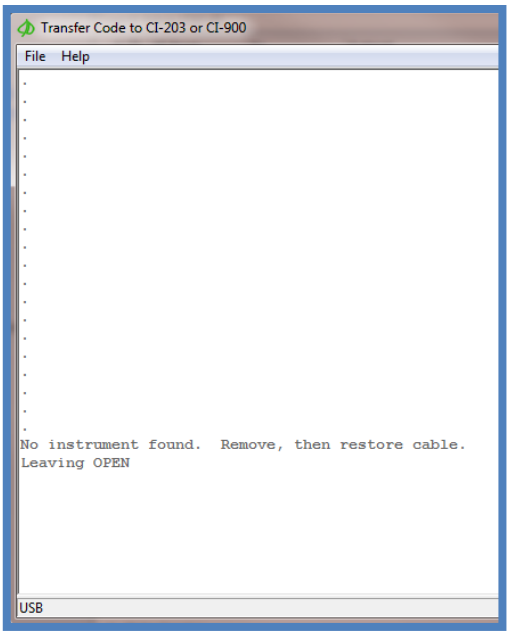
9. Wait for the flash to be erased and then written. When the firmware transfer is complete, the software will indicate reset sent, followed by "leaving open". The CI-900 will power off.



10. Power on the CI-900 and check the firmware version at the top of the display.

The Transfer Code software application will indicate that no instrument is found, if the CI-900:

- is not connected to the computer
- is not powered on
- driver is not properly installed



If this message is seen, make sure:

- the CI-900 is connected via mini-USB
- the driver is installed
- the CI-900 is powered on

CLEANING AND MAINTENANCE OF THE CI-900

The CI-900 housing can be wiped down with a damp cloth if the unit becomes dirty or dusty. Please make sure to always keep the IN and OUT ports on the front panel clear from any obstructions.

The water in the electrochemical cell of the unit needs to be refilled periodically using distilled water. The hours of use between refills will depend on the humidity and temperature of the environment the CI-900 is typically used in. Warm or low humidity/dry environments will required more frequent refills. Please contact support@cid-inc.com for more information or to schedule instrument servicing.

Refilling the Electrochemical Sensor

The liquid reservoir must contain a sufficient amount of electrolyte at all times. The electrocatalytic sensor operates utilizing water and therefore requires replenishment of the electrolyte solution (1 ml/day while operating using continuous mode). Depending on the mode of operation and the environment in which it is used, the sensor cell may need to be replenished with distilled water every 2-3 weeks if Chamber In (B) is not set to ON and filled with distilled water. The electrolyte level should be monitored on regular basis and prior to operation for an extended period of time. The analyzer will arrive filled with the proper electrolyte.

Only refill with distilled water. Refilling is needed on a regular basis if the unit is being run with dry gas and Chamber In is not on and filled with water. If Chamber In (B) is run continuously with distilled water, the level of water in the sensor should not change very much and the levels need only be checked every 6 months.

Check the sensor every 2-3 weeks if run continuously in very dry environments (<20% RH). It is recommended to refill the sensor before the liquid level drops 20 ml. How often the reservoir needs to be refilled will depend on the conditions the instrument is used in (temperature, relative humidity). The red port on the sensor is used for refilling. The red plug in the port is removed and a syringe inserted (provided with the instrument).

Note: A dry gas being fed into the CI-900 at 25 ^{0}C will cause an expected water loss of 0.1 ml/hr; at 30 ^{0} C a dry gas will cause a loss of 0.3 ml/hr. Expected water loss can be up to 3 ml/day when feeding dry gas through the CI-900.

To Use Conditioning Chamber In (B)to Refill the Sensor (RECOMMENDED):

Conditioning Chamber In, in special mode with water filtration, can be used to help keep the electrochemical cell hydrated, with longer periods of time between needing to refill the electrochemical sensor. The fastest way to add water will always be to open the unit and directly refill.

1. Fill Chamber In (B)to the fill-line located on the back of unit using distilled or deionized water

2. Turn Chamber In to "on."

3. Allow the unit to measure room air, while bubbling, for 62 hours or until the unit has returned to the overall sensor full weight (found in the Production Test Check Sheet at end of User Manual.)

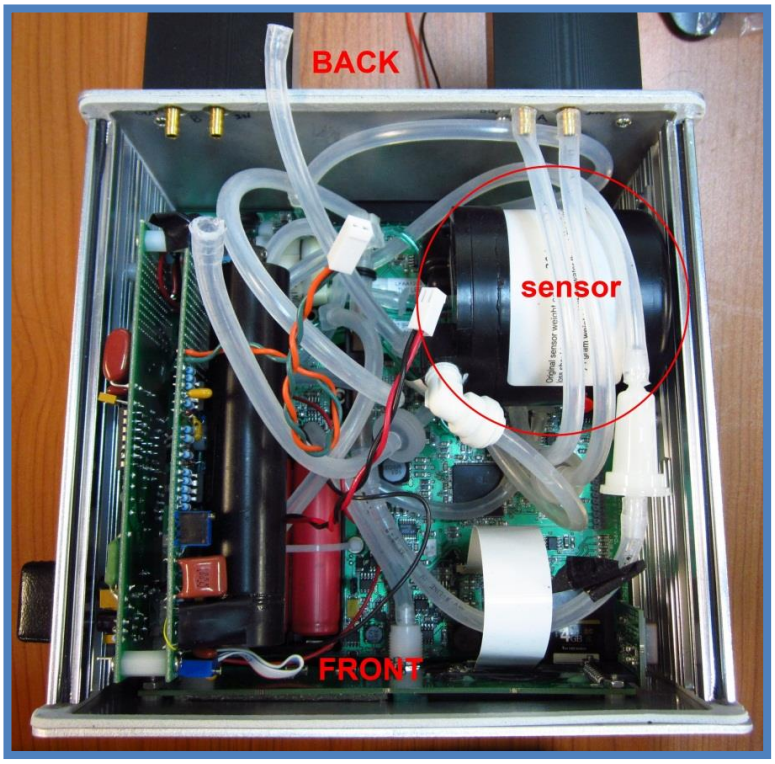
Note: the refill dead time is proportional to the R.H. of the measured gas and the duration of measurement. For example: dry gas at <10% R.H. will have ~1:1 measurement to dead time. Room air at 25-30% R.H. will have ~1:2 ratio. Any unit that measures ~40% R.H. should, in theory, never dry out.

To Refill the Sensor By Opening Up the CI-900:

BE EXTERMELY CAREFUL NOT TO DRIP WATER ONTO ANY INTERNAL PARTS OF THE CI-900!

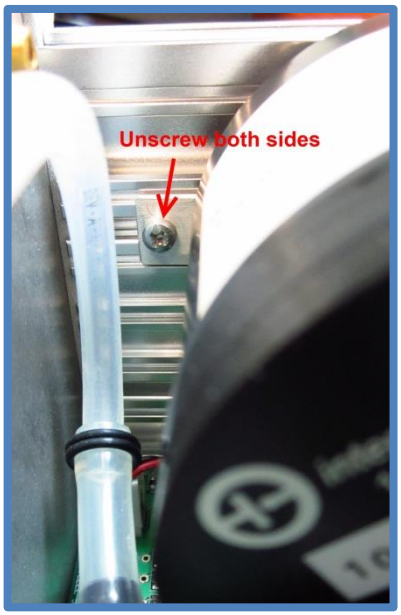
1. Open the hard-sided case of the instrument; remove the top and back panels. The black plastic bezels that surround the front panel and back panel can be removed by unsnapping the middle of the side where there is a slight indentation. These bezels cover the screws that keep the top on and the front and back panels on.
2. Remove the terminal block from the back panel by pulling or tugging straight away from the back. Remove the top two screws from the front panel and loosen the bottom two screws, then remove all 4 screws on the back panel.
3. The back panel can be separated from the case by a slight amount to allow you to get your fingers inside. This will allow you to access the side of the electrochemical sensor without disconnecting the tubing that runs across the top of the sensor connecting to conditioning chamber A. The back panel can be flipped up, to unscrew the sensor or remove/insert it in the CI-900.
4. The top can then be popped off by pulling out on one side of the case while pulling up on the top on the same side.

5. Locate the black electrochemical sensor labeled “Interscan.”

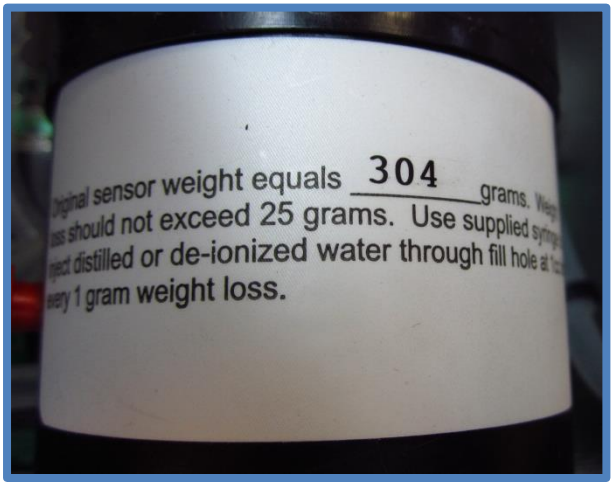


6. Disconnect the tubing entering the white connection on the sensor by holding the base of the white connector in your hands firmly while sliding out the tubing. You may need to push upwards slightly on the connector to release the tubing.
7. Disconnect the tubing from the black connector. This is easiest done with the back panel removed and will require some wiggling to free the barbs and remove it.

8. Unscrew the sensor from the side panel. There is a screw on either side of the sensor attaching the base of the sensor to the side of the CI-900 instrument housing.
9. Finally, disconnect the wiring that clips onto the circuit board from the sensor. This is an easy connection once you can access it with the back panel flipped upwards.
10. Lift the sensor out of the instrument.
11. Weigh the sensor on an analytical balance and compare it with the weight written on the sensor. Figure out the amount of water that needs to be replaced by subtracting the current sensor weight from the original sensor weight. (1g = 1 ml of water)
12. Fill the syringe with distilled water.
13. Remove the red plug from the port. Insert the needle of the syringe in the port.



14. Inject water **SLOWLY** into the cell until the sensor returns to its original weight.
15. Do not overfill the cell. **Water leaking out of the cell could be mixed with sulfuric acid.**
16. Dry any excess water from the outside of the sensor before putting it back in the CI-900.
17. Allow the sensor at least 1 hour after refilling to equilibrate. Then, turn the CI-900 on and resume measurements.


sensor weight equals 304 grams.
should not exceed 25 grams. Use supplied
distilled or de-ionized water through fill hole
1 gram weight loss.

Note: Weighing the entire CI-900 unit on an analytical balance after the sensor has been refilled will allow you to monitor the water level of the sensor, by keeping track of the weight loss of the whole CI-900 unit. Remember to always weigh the CI-900 with the same setup and to follow the instructions above to remove and refill the sensor, when it has lost 20-25 grams of water. High humidity can add water to the sensor; overfilled sensors have been tested and do not cause a problem.

INTERFERING GASES

No analytical method is completely specific. Gases present in the environment, other than the "target" gas of a measurement, may affect instrument response. Interferences are not necessarily linear, and may also exhibit time dependent characteristics.

The table below details the approximate concentration in parts per million of interfering gas required to cause a 1 ppm detection in the ethylene analyzer. Please note that the response values given are not absolute.

Table 1: Interfering Gas and the CI-900 sensor

INTERFERING GAS														
C_2H_4 (ethylene) ANALYZER	acetone	acetylene	Cl_2	CO	CO_2	ethyl alchohol	ethylene glycol	EtO	Freon	glutaral-dehyde	H_2	isopropyl alcohol	N_2O	NH_3
	300	4	15 [N]	8	$>10^4$	150	0.3	0.2	$>10^4$	1	500	0.4	$>10^5$	200

[N] = Negative interference

Ripening fruit emit a complex mixture of hydrocarbons, including ethylene. Oxidation of these other gases in the electrochemical sensor cannot be readily distinguished from ethylene. This causes the ethylene value to be falsely high in the presence of interfering gas. CID Bio-Science is currently experimenting to see the extent of the interference, as well as testing a method to absorb some of the competing gases and provide better ethylene measurements. Using Conditioning Chamber B with distilled water has been shown to filter out alcohols and produce less interference (page 32). Please monitor the CI-900 support forum for progress updates.

WARNINGS

- Read this manual carefully before using: this manual should be read by anyone who will be operating the CI-900.
- By following the guidelines, the CI-900 will function according to the specifications in this instruction manual.
- All repairs should be performed by a CID technician.
- The analyzer must be used to measure the rate of ethylene in the presence of nitrogen, oxygen and carbon dioxide. All other gases in high concentration could lead to erroneous measurements, or the destruction of the sensor. Do not use the instrument in the presence high concentrations of aromatic solvents, hydrocarbons or other volatile organic compounds, such as in unventilated painting rooms or chemical storage rooms.
- Damage to the analyzer can occur if the fluid reservoir level is too low or if the inlet and outlet gas connections are blocked while the pump operates. This can cause false readings or irreparable damage to the sensor.
- If smoke comes out of the analyzer, turn off the power immediately and contact CID.
- Keep the analyzer in a clean and ventilated room at ambient temperature.
- Do not allow fluid to aspirate in the analyzer, which can destroy the sensors.
- **Do not use the CI-900 in a high RF (radio frequency) environment.** High RF will disrupt the CI-900.
- ESD (electrostatic discharge) can also interfere with CI-900.
- Do not tilt the CI-900 when a liquid is in Chamber B.

The analyzer has a reservoir containing 1 mol of sulfuric acid (2N H2SO4). Avoid contact with skin and eyes. If contact occurs, rinse thoroughly with water or use an eyewash or safety shower. Do not drink the contents of the fluid reservoirs as it could cause chemical burns. See Appendix I for the safety data sheet and further information on sulfuric acid.

TECHNICAL SUPPORT

If you have a question about the CI-900, first look in the CI-900 Operation Manual. There is also online support available for the CI-900 at http://www.cid-inc.com/ci-900-support.php. If you cannot find the answer, you can contact a Technical Support Representative located in your country. CID Bio-Science, Inc. is committed to provide customers with high quality, timely technical support. Technical support representatives are to answer your technical questions by phone or by e-mail at support@cid-inc.com.

CID Bio-Science, Inc.'s contact information:

CID Bio-Science, Inc.
1554 NE 3rd Ave
Camas, WA 98607 USA

Phone: 800-767-0119 (U.S. and Canada)
360-833-8835
Fax: 360-833-1914

Internet: http://www.cid-inc.com
E-mail: support@cid-inc.com

Customer Service

Customer Service Representatives answer questions about specifications and pricing, and sell all of the CID Bio-Science, Inc. products. Customers sometimes find that they need CID Bio-Science, Inc. to upgrade, recalibrate or repair their system. In order for CID Bio-Science, Inc. to offer these services, the customer must first contact us and obtain a Return Merchandise Authorization (RMA) number. Please contact a customer service representative for specific instructions when returning a product.

Frequently Asked Questions

If there are any questions about the CI-900, please check the Frequently Asked Questions below, as well as the CID Bio-Science support webpage and forum at http://www.cid-inc.com/ci-900-support.php.

1. What type of fruit produces ethylene?

    a. Climacteric fruits refer to fruits that have high respiration rate during the fruit's ripening. During the ripening process of climacteric fruits, the production of a phytohormone, ethylene, dramatically increases up to 1000-fold of the basal ethylene level. Climacteric fruits are ones that are able to ripen after being picked. An example of climacteric fruit is bananas; they are picked and shipped green and then ripen at a later time (often in the store or home). Climacteric fruits include, but are not limited to, apples, apricots, avocados, bananas, cantaloupes, figs, guavas, kiwis, mangoes, nectarines, peaches, pears, persimmons, plums, and tomatoes. [Source: Wikepedia.com]

2. What should I do if I see moisture develop in the tubing when monitoring a fruit in the chamber?

    a. Silica gel can be used to dry out the gas stream, either before or after the gas passed the electrochemical sensor. Silica gel in conditioning chamber B is used to treat gas after the intake and before the sensor. Using silica gel in conditioning chamber A will dry out the air going back to the fruit chamber. To use the conditioning chamber, fill it with silica gel. Then go to the Setup Menu and Chamber. Turn on the chamber that is filled with silica gel. Refer to the flow path diagram in the Setup<Chamber section of the User Manual for more information.

3. Can the data output be directly linked to the computer, and by what type of connection can be used? And is it MAC and/or PC compatible?

    a. The unit has a SD card and the format can be read on any Mac or PC. Data can also be downloaded via USB.

4. How do I change how the data appears in the .csv file?

    a. If data isn't displaying properly, try saving the file as a .csv file type and re-opening it. If saving as a .csv does not fix how the data is displayed, you may need to change the separator value on your computer.

        To change the separator in all .csv text files:

1. In Microsoft Windows, click the Start button, and then click Control Panel.

2. Open the Regional and Language Options dialog box.

3. Do one of the following:

    a. In Windows Vista and 7, click the Formats tab, and then click Customize this format.

    b. In Windows XP, click the Regional Options tab, and then click Customize.

4. Type a new separator in the List separator box. For example, type ","

5. Click OK twice.

NOTE: After you change the list separator character for your computer, all programs use the new character as a list separator. You can change the character back to the default character by following the same procedure.

5. How do I create and open a file to start using the CI-900?

    a. To start using the CI-900, you need to create a file to save data into. Go to File<Create. Change the file00 to the desired file-name and press save. Next, open the file to save measurements. Go to File<Open and use the arrows to highlight the newly created file. If the value next to the file-name is a negative number, this indicates an error. You should delete the file and create it again. Then, open it and check that the value is zero. Now, you can save data into this file.

6. What is 1-MCP?

    a. 1-MCP is short for 1-Methylcyclopropene. This is a synthetic plant growth regulator, which is structurally related to ethylene (natural plant hormone). When applied to fruit, 1-MCP binds to ethylene receptors without triggering the signal cascade that leads to climacteric ethylene biosynthesis and ripening. Commercially, it is used to slow down the ripening of fruit and to maintain the freshness of cut flowers. The chemical formula is C_4H_6.

7. What consumables come with the CI-900?

    a. The CI-900 and CI-900FK ship with a humidity scrubber (silica gel) and potassium permanganate, an ethylene scrubber (Purafil Fresh Air Sachets).

If the CI-900 includes the optional CO_2 sensor, a jar of CO_2 scrubber (soda lime) is provided. Please contact CID technical support with any questions.

8. What are some possible applications for the CI-900?

    a. The CI-900 could be used to help optimize Controlled Atmosphere Storage Rooms and prevent losses. Ethylene is an important and sensitive marker for ripening of fruits. Other postharvest research applications are possible.

    b. In addition to plants, some microorganisms, including fungi and bacteria, synthesize ethylene. Microorganisms can cause great losses in the postharvest industry through disease and mold, so research into ethylene and the pathogen-host interaction is important. A common plant pathogen that produces ethylene is *Botrytis cinerea*.

    c. Measuring ethylene concentration in the air of rooms where young apple trees in pots are stored adjacent to refrigerated apple storage rooms, in order to assess the safety to young apple trees. During the winter months, the safe level for storage of first year apple trees is below 50ppm.

    d. Commercial apple growers are could monitor the ethylene levels of empty refrigerated rooms before storing bare-root nursery trees. Rooms should be empty of ethylene before storing nursery trees and often growers have no way to monitor this.

    e. Monitoring ethylene emission from industrial sources. Ethylene is of interest because it plays a role in atmospheric ozone chemistry. This will be dependent on interfering gas and the source of industrial emissions.

9. How long does it take to recharge the battery?

    a. About four hours. The unit may be operated while the battery is charging.

10. What happens in the cell runs out of water?

    a. If the cell runs out of water, the lead electrode could undergo sulfation. This would affect the sensitivity by reducing the active area on the lead electrodes. It is more likely that a lack of water in the cell decreases the activity of the electrolyte and increases the resistivity of the Nafion membrane. Both will affect the background current and response time of the cell.

11. What are the advantages of the CI-900FK over the standard CI-900?

a. Both are portable, but the field kit includes the other components shown on the website (http://www.cid-inc.com/ci-900FK.php), such as the fruit chamber and wand and hard-sided carrying case. The Field Kit is designed to make measurement of fruits on a tree (non-destructively) more convenient. A fan is built into the chamber to mix the air around the fruit.

12. Is the silica gel in the Chamber B absolutely needed? If not, when should it be used?

    a. Both chambers are optional. The most common use for chamber B is to separate light hydrocarbons, such as alcohol, from the gas stream which may interfere with the measurement. The most common use for chamber A is to be filled with potassium permanganate, so that it cleans all ethylene and other hydrocarbons from the gas stream, so that any ethylene that is measured must have come from the fruit in the chamber.

13. During a monitoring experiment, will the sealed fruit chamber influence the result as time goes on?

    a. The air should be scrubbed using chamber A filled with potassium permanganate.

14. Does the electrochemical sensor need to be filled every 2-3 weeks and does it require opening the instrument each time?

    a. Water may be added to the electrochemical sensor by putting water in Chamber B. If water is being used in chamber B for separating out alcohols, then refilling of the sensor will never be necessary. Similarly, if the sensor is used in a humid environment, the sensor will not dry out.

15. Where are temperature and humidity measured?

    a. The temperature and relative humidity sensors are located inside the CI-900, before the electrochemical sensor.

16. What type of membrane does the electrochemical sensor have?

    a. The electrochemical sensor uses a nafion or nafion-like membrane.

17. What is the detection rate of the CI-900, taking into account the weight of the fruit (or sample) and the time measured?

    a. For the CI-900:

       Flow rate: 0.2L/min = 15.0L/hr

Sensitivity to C_2H_4: 0.1 µL/L or 100 nL/L

Therefore, the CI-900 optimally detects around 1500 nL/hr. If the specimen weighs 50 grams, then the detection rate is: 30 nL C_2H_4/gfw/h. The unit is nanoliters of ethylene per gram fresh weight per hour.

Guidelines for Bag Sampling

The following guidelines are for collecting air samples in the included samples bags. In order to collect an air sample, you must pump air into the bag (pump not included). These bags are often used to collect ambient air samples to analyze later in a laboratory, using a gas chromatograph, or can be connected to the CI-900 using the accessory parts.

1. Ensure that the bag material and fittings are appropriate for the compounds to be sampled.
2. Use only PTFE tubing to connect the sample bag to the pump to prevent sample loss by adsorption on tubing walls.
3. Before using, flush the bag thoroughly with purified air or nitrogen.
4. Analyze the sample within 24 to 48 hours. Long-term storage of air-contaminant mixtures in bags is not recommended.
5. Do not ship sample bags by air unless the cargo cabin is pressurized.
6. Do not overfill bags
7. Secure polypropylene value when opening/closing by holding side stem while turning entire upper portion of fitting one revolution.
8. Store bags flat. Do not roll or crease bags during storage.
9. Do not use bags at temperatures above 140 ^{0}F (60 ^{0}C).
10. Bags are designed for single use only.

To Collect a Sample Using a Sample Bag

1. Flush the bag at least 3 times with purified air or nitrogen before use.
2. To fill a bag, connect PTFE tubing from the exhaust port of an air sample pump to the hose connection on the bag (stem protruding from the side of the fittings).
3. To open the shut-off valve, hold the side stem and turn the entire upper portion of the fitting (including the brown syringe port and the white section to which it is attached) counterclockwise one revolution. Turn on the pump and sample.
4. Avoid filling any bag more than 80% of its maximum volume.
5. When sampling is complete, turn off the pump. To close the shut-off valve, hold the side stem and turn the entire upper portion of the fitting clockwise until it is snug.

6. To withdraw samples using a needle and syringe, carefully insert the needle into the septum port in the center of the brown cap and pierce the septum. Do not allow the needle to puncture the bag material when piercing the septum.

7. Do not use the fitting valve as a handle or hanging device. Although it is durable, it is not intended for these uses.

Analyzing a Sample Bag with the CI-900

- Connect the sample bag to the IN port of the CI-900.
- Open the sample bag to allow gas to start flowing to the CI-900.
- It takes about 3-5 minutes to measure a sample bag if the concentration of ethylene before measuring the sample bag is low.

CID BIO-SCIENCE, INC. HARDWARE WARRANTY

Important: Please Read!

Seller's Warranty and Liability: Seller warrants new equipment of its own manufacturing against defective workmanship and materials for a period of one year, of a single shift operation, from date of receipt of equipment - ***the results of ordinary wear and tear, neglect, misuse, accident and excessive deterioration due to corrosion from any cause is not to be considered a defect.*** Any defect must be called to the attention of CID Bio-Science, Inc., Camas, Washington, USA, in writing, within 90 days after receipt of the unit.

Seller's liability for defective parts is limited to the repair or replacement of any part of the instrument without charge, if CID Bio-Science, Inc.'s examination discloses that part to have been defective in material or workmanship, and in no event shall exceed the furnishing of replacement parts F.O.B. the factory where originally manufactured. No equipment may be repaired or altered by anyone not authorized by CID Bio-Science, Inc.

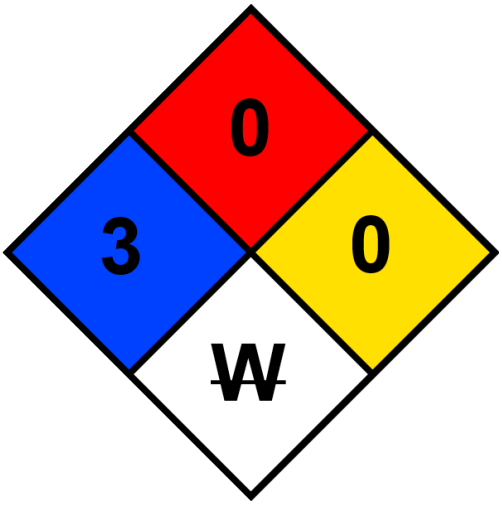
Material and equipment covered hereby, which is not manufactured by Seller, is to be covered only by the warranty of its manufacturer. Seller shall not be liable to the Buyer for loss, damage, or injury to persons (including death), or to property or things, whatsoever, including, but without limitation, products processed by the use of the equipment; or for damages of any kind or nature (including, but without limitation, loss of anticipated profits), occasioned by or arising out of installation, operation, use, misuse, nonuse, repair, or replacement of said material and equipment, or out of the use of any method or process for which the same may be employed. The purchaser is to pack, ship, or deliver the instrument to CID Bio-Science, Inc., in Camas, Washington, USA, within 30 days after CID Bio-Science, Inc. has received written notice of the defect at the customer's expense. No other arrangements may be made unless otherwise approved in writing by CID Bio-Science, Inc.

The use of this equipment constitutes Buyer's acceptance of the terms set forth in this warranty. There are no understandings, representations, or warranties of any kind, express, implied, statutory, or otherwise ***(including, but without limitation, the implied warranties of merchantability and fitness for a particular purpose)***, not expressly set forth herein.

APPENDIX I: MATERIAL SAFETY DATA SHEET FOR 2N SULFURIC ACID SOLUTION

SECTION 1: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Sulfuric Acid, 2N
Catalog Codes:
CAS#: Mixture.
RTECS: Not applicable.
TSCA: TSCA 8(b) inventory: Sulfuric acid; Water
CI#: Not applicable.
Synonym:
Chemical Name: Not applicable.
Chemical Formula: Not applicable.



Contact Information:

CID Bio-Science, Inc.
1554 NE 3rd Ave
Camas, WA 98607 USA
Phone: 1-800-767-0119
(U.S. and Canada): 1-360-833-8835

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300
International CHEMTREC, call: 1-703-527-3887
For non-emergency assistance, call: 1-281-441-4400

SECTION 2: COMPOSTION AND INFORMATION ON INGREDIENTS

Composition:

Name	CAS #	% by Weight
Sulfuric acid	7664-93-9	9.8
Water	7732-18-5	90.2

Toxicological Data on Ingredients: Sulfuric acid: ORAL (LD50): Acute: 2140 mg/kg [Rat.]. VAPOR (LC50): Acute: 255 ppm 4 hour(s) [Rat.].

SECTION 3: HAZARDS IDENTIFICATION

Potential Acute Health Effects:
Extremely hazardous in case of skin contact (corrosive, irritant), of eye contact (irritant), of ingestion, of inhalation. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Extremely hazardous in case of skin contact (corrosive, irritant), of eye contact (irritant), of ingestion, of inhalation. Nonsensitizer for skin. Non-permeator by skin. CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated or prolonged inhalation of vapors may lead to chronic respiratory irritation.

SECTION 4: FIRST AID MEASURES

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

Skin Contact:
If the chemical got onto the clothed portion of the body, remove the contaminated clothes as quickly as possible, protecting your own hands and body. Place the victim under a deluge shower. If the chemical got on the victim's exposed skin, such as the hands: Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.
Inhalation:
Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.
Serious Ingestion: Not available.

SECTION 5: FIRE AND EXPLOSION DATA

Flammability of the Product: Non-flammable.
Auto-Ignition Temperature: Not applicable.
Flash Points: Not applicable.
Flammable Limits: Not applicable.
Products of Combustion: Not available.
Fire Hazards in Presence of Various Substances: Not applicable.
Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions: Not applicable.
Special Remarks on Fire Hazards: Not available.
Special Remarks on Explosion Hazards: Not available.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

SECTION 7: HANDLING AND STORAGE

Precautions:
Keep container dry. Do not breathe gas/fumes/ vapor/spray. Never add water to this product In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes Keep away from incompatibles such as alkalis. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:
May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package. Corrosive materials should be stored in a separate safety storage cabinet or room.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
Sulfuric acid TWA: 1 STEL: 3 (mg/m3) from ACGIH Consult local authorities for acceptable exposure limits.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance: Liquid.
Odor: Odorless.
Taste: Not available.
Molecular Weight: Not applicable.
Color: Clear Colorless.
pH (1% soln/water): 2 [Acidic.]
Boiling Point: The lowest known value is 100°C (212°F) (Water).
Melting Point: Not available.
Critical Temperature: Not available.
Specific Gravity: The only known value is 1 (Water = 1) (Water).
Vapor Pressure: The highest known value is 17.535 mm of Hg (@ 20°C) (Water).
Vapor Density: The highest known value is 0.62 (Air = 1) (Water).
Volatility: Not available.
Odor Threshold: Not available.
Water/Oil Dist. Coefficient.: The product is much more soluble in water.
Ionicity (in Water): Not available.
Dispersion Properties: See solubility in water.
Solubility: Easily soluble in cold water, hot water. Insoluble in methanol, diethyl ether, n-octanol.

SECTION 10: STABILITY AND REACTIVITY DATA

Stability: The product is stable.
Instability Temperature: Not available.
Conditions of Instability: Not available.

Incompatibility with various substances:
Extremely reactive or incompatible with alkalis. Slightly reactive to reactive with metals.

Corrosivity:
Extremely corrosive in presence of aluminum, of zinc. Highly corrosive in presence of steel, of copper. Slightly corrosive to corrosive in presence of stainless steel(304), of stainless steel(316). Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Reacts violently with water especially when water is added to the product. (Sulfuric acid)

Special Remarks on Corrosivity: Not available.
Polymerization: No.

SECTION 11: TOXICOLOGICAL INFORMATION

Routes of Entry: Eye contact. Inhalation. Ingestion.
Toxicity to Animals: LD50: Not available. LC50: Not available.

Chronic Effects on Humans: The substance is toxic to lungs, mucous membranes.
Other Toxic Effects on Humans: Extremely hazardous in case of skin contact (corrosive, irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans: Not available.
Special Remarks on other Toxic Effects on Humans: Not available.

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity: Not available.
BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.
Special Remarks on the Products of Biodegradation: Not available.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal:

SECTION 14: TRANSPORT INFORMATION

DOT Classification: CLASS 8: Corrosive liquid.
Identification: Sulfuric acid, solution: UN2796 PG: II
Special Provisions for Transport: Not available.

SECTION 15: OTHER REGULATORY INFORMATION

Federal and State Regulations: TSCA 8(b) inventory: Sulfuric acid; Water

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:
WHMIS (Canada):
CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.
DSCL (EEC): R35- Causes severe burns.
HMIS (U.S.A.):
Health Hazard: 1
Fire Hazard: 0
Reactivity: 0
Personal Protection:
National Fire Protection Association (U.S.A.):
Health: 1
Flammability: 0
Reactivity: 0
Specific hazard:
Protective Equipment: Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

SECTION 16: OTHER INFORMATION

References: Not available.
Other Special Considerations: Not available.
Created: 12/21/2010
Last Updated: 4/23/2012

APPENDIX II: PROCEDURE FOR VALIDATION OF CI-900 USING FRUIT

The following methods should be run consecutively on a given replicate and repeated for each new replicate (new specimen). At least 5 replicates for pre-climacteric (un-gassed or still green) apples, bananas, or avocados should be run. The data from method 1 and 2 can be combined into a table. The results from method 3 can be graphed, as a figure, to show the trend over time.

Method 1: Sampling with No Filtration/Trapping

The purpose of this method is to determine what response the sensor has without trapping of interfering gases. This can be thought of as the baseline response

Procedure:

1. Turn on the CI-900, verify chambers are set to off and flow is set to 200 ml/min.
2. Connect experimental setup as show in Figure 15.
3. Load the sample specimen into the fruit chamber.
4. Start measuring the fruit headspace with the CI-900.
5. After sampling the headspace for 5 minutes, or a set period of time of your choosing, take a syringe sample and run it in the GC (gas chromatograph). Record result in spreadsheet program, such as Microsoft Excel.
6. Vent the fruit chamber, record the result in Excel and start method 2. The fruit chamber should be well vented to flush out any plant gases between measurements.

Method 2: Sampling with Filtration/Trapping

The purpose of this method is to determine what response the sensor has with trapping of interfering gases by H_2O. This can be thought of as the effect to the instantaneous measurement.

Procedure:

1. Fill Conditioning Chamber_Inbound (B) with distilled water and clean the water using a sodium permanganate tube connected to the inlet of the CI-900, until the background signal is below 20ppb.
2. Load the sample specimen into the fruit chamber.
3. Start measuring the fruit headspace with the CI-900.
4. After sampling the headspace for exactly 5 minutes, take a syringe sample and run it in the GC (gas chromatograph). Record result in spreadsheet program, such as Microsoft Excel.
5. Vent the fruit chamber, record the result in Excel and start method 3.

Method 3: Long-Term Monitoring with Filtration

The purpose of this method is to determine the effeteness of the interfering gas trap for long term measurements. This will require the trap to self-regenerate between consecutive measurements. The regeneration time is defaulted to 6 minutes; however for some species a greater time may be needed. By keeping the default value for avocados we can better compare results and will demonstrate the weakness of the method.

Procedure:

1. Fill Conditioning Chamber_In (B) with distilled water and clean the water using a sodium permanganate tube connected to the inlet of the CI-900, until the background signal is below 20ppb.
2. Verify that Chamber In is set to “special” with a sufficient cleaning period for the produce being monitored.
3. Load the sample specimen into the fruit chamber.
4. Start measuring the fruit headspace with the CI-900.
5. Allow the system to run for 5 measurement and cleaning cycles.
6. Vent the chamber and load the data file to a computer.
7. Switch to the next replicate and begin at method 1 again.

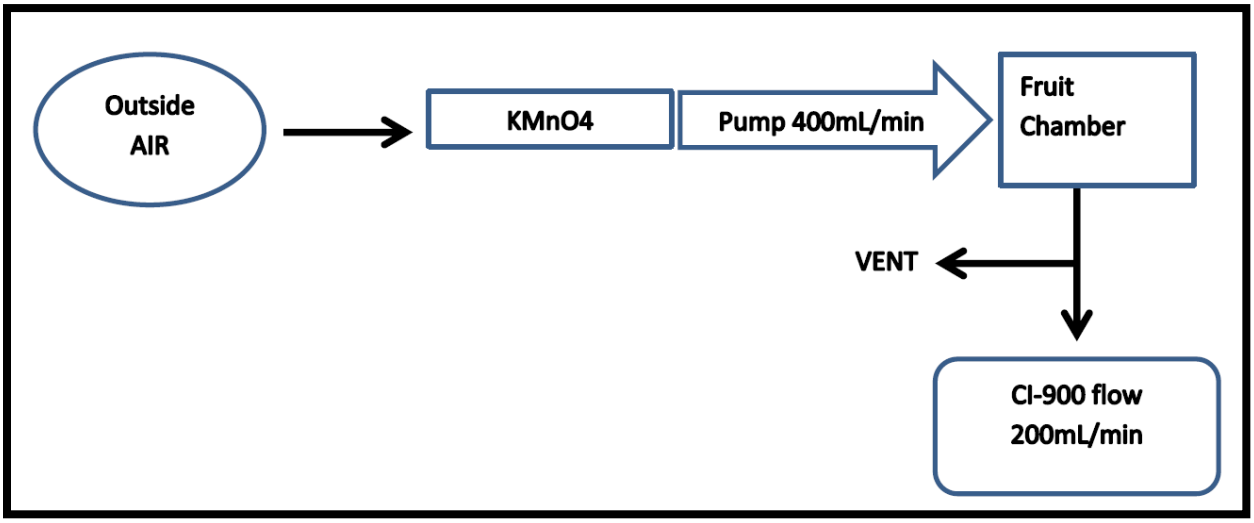


Figure 15: Set-up for fruit chamber using potassium permanganate ($KMnO_4$) to scrub ethylene from the outside air.

CI-900 PRODUCTION TEST CHECK SHEET

SERIAL NUMBER:
Firmware Version:

SENSOR:	Weight (grams):
C2H4	
CI-900 fully assembled	

Optional Sensors	Included (Yes/No)
C2H4 Low Resolution	
C02 High Resolution	
CO2 Low Resolution	
O2	

CALIBRATION PARAMETERS	C2H4 High Resolution
Internal offset	
Internal gain	
Calibrated RH	
Calibrated T	
RH slope	
RH offset	
T slope	
T offset	

NOTES: _____

WARRANTY REGISTRATION CARD

1554 NE 3rd Ave, Camas, WA 98607, USA
Phone: (360) 833-8835 Fax: (360) 833-1914 e-mail: sales@cid-inc.com Web: www.cid-inc.com

PRODUCT REGISTRATION CARD

Please complete and return this form to CID within 30 days to validate your Warranty on Parts and Labor.

Registration Information:

Your Name:_____ Title:_____

Company/University:_____

Address:_____

City:_____ State:_____ Zip:_____

Country:_____Email_____

Phone:_____ Fax:_____

CID Serial Number(s):_____

Purchase Date:_____ Purchase Price:_____

FOLD ON DOTTED LINE

Your opinions will help improve our service. Please answer the following questions.

1. What was the basis of your product selection?

□ Representative Recommendation
□ Price
□ Product Features
□ Product Design
□ Technical Specifications
□ Brand Name
□ Warranty
□ Service
□ Other _____

2. What other competing brands did you consider? _____

3. Where did you first learn of this product?

□ Advertisement in _____
□ Representative
□ Friend/Colleague
□ Exhibit
□ Other _____

4. Who selected this product?

□ I did
□ Research Group
□ University Department
□ Purchasing
□ Other _____

5. Comments/Suggestions:

_____

_____

_____